World Journal of Medical Sciences 10 (4): 415-420, 2014
ISSN 1817-3055

DOI: 10.5829/idosi.wjms.2014.10.4.83217

An Evaluation of Weaning Trials in Relation with Mean Arterial Pressure, Respiratory Rate, Arterial Blood Gases and Successful Extubation

[1]K. Manjush, [1]Sammita J. Jadhav, [2]Balasaheb Y. Pawar and [1]Chris Sara Mathew

[1]Symbiosis Institute of Health Sciences, Symbiosis International University, Pune, India
[2]Department of Intensive Care Medicine, Deenanath Mangeshkar Hospital, Pune, India

Abstract: Weaning or liberation from mechanical ventilation is a phase of transition from total ventilator support to spontaneous breathing. The aim of this study was to compare the effects of pressure support (PS), continuous positive airway pressure (CPAP) and T-Piece trials on mean arterial pressure, respiratory rate, arterial blood gases and successful extubation. In this prospective, observational study, 75 consecutive patients requiring mechanically ventilation for > 48 hours were considered eligible for this study. Patients were randomly divided into three groups (PS: n= 35, T-Piece: n= 30, CPAP: n= 10). Group PS received a PS of 7-10 cmH_20 and PEEP of 5 $cmH_20$with $FiO_2 \leq 0.4$, Group T-Piece on 40% venturi and Group CPAP received PEEP of 5 cm H_2O with $FiO_2 \leq 0.4$. Mean arterial pressure, respiratory rate and arterial blood gas analysis to assess pH, PaO_2 and $PaCO_2$ was documented at 30 minutes and 120 minutes of spontaneous breathing trial (SBT) and also after 120 minutes post extubation. Patients were on constant monitoring for the next 24 hours, to assess the success of extubation. *Conclusion*: From our study, it was concluded that mean arterial pressure, respiratory rate, pH, PaO_2, $PaCO_2$, rate of extubation and reintubations were comparable amongst the 3 methods of weaning and there was no significant difference between the effects of pressure support (PS), continuous positive airway pressure (CPAP) and T-Piece trials on the observed parameters($p>0.05$).

Key words: Weaning · Pressure Support · Continuous Positive Airway Pressure · T- Piece · Mean Arterial Pressure · Arterial Blood gases · Extubation · Reintubation

INTRODUCTION

The weaning or liberation process is an important phase which may require up to 50% of the total duration of mechanical ventilation [1]. It is important to identify the right time to initiate the weaning process and extubate a patient, since reintubation after early extubation is often associated with an increased risk of mortality and morbidity [2 - 4]. Also, an unnecessary delay in extubating a patient who has successfully weaned may increase morbidity and mortality due to complications associated with prolonged mechanical ventilation [5, 6, 9]. Some of the major factors associated with weaning outcome are resolution of the precipitating illness, presence of comorbid illnesses, cause of acute respiratory failure, protocol and the method of weaning. Among these, the method of weaning is an important variable because of the potential to intervene. Some of the major studies on weaning have been conducted using spontaneous T-piece trials and pressure support (PS) ventilation [7]. In these studies, readiness to wean has been assessed by an initial 2 hours T-piece trial and the patients who tolerate this trial are extubated whereas those failing this trial are randomized to different weaning methods. The reintubation rates of the initial spontaneous breathing trials (SBTs) have ranged from 10 to 20% [6-9]. It is generally accepted that a spontaneous breathing trial (SBT), performed with pressure support (PS), continuous positive airway pressure (CPAP) alone or a T-Piece is the best way to assess whether the patient is able to breathe and maintain the vitals on his or her own before extubation [1, 10, 11]. We aimed at evaluating the effects of pressure support (PS), continuous positive airway pressure (CPAP) and T-Piece trials of weaning in relation with the respiratory rate, mean arterial pressure, arterial blood gases and successful extubation.

Corresponding Author: K. Manjush, Symbiosis Institute of Health Sciences, Symbiosis International University, Pune, India.

MATERIALS AND METHODS

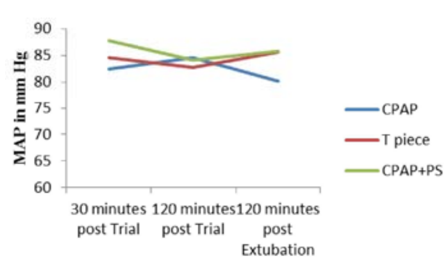
This study was approved by the institutional review board and departmental dissertation committee of Symbiosis Institute of Health Sciences, Pune. This prospective, observational study enrolled 75 adult patients who were intubated and ventilated for more than 48 hours for various causes, during July 2012 to February 2013. All hemodynamically and clinically stable patients who were more than 18 years of age, receiving mechanical ventilation (MV) support in the intensive care unit (ICU) for different causes, assessed for readiness by critical care physicians for undergoing weaning and extubation trial were included in the study. Patients with do not resuscitate (DNR) status, mechanical ventilation requirements <48 hrs, order not to reintubate and less than 18 years of age were excluded from the study. All patients were monitored with all vital parameters like respiratory rate, heart rate, pulse oximetry, electrocardiography and arterial blood pressure.

Study Protocol: All intubated patients on mechanical ventilation and ready for weaning were clinically evaluated by the critical care physicians. Prior to weaning from mechanical ventilation, the patient was ventilated on either assist control (AC)/ synchronized intermittent mandatory (SIMV) mode of ventilation. During weaning intervention, the patient's mode of ventilation was selected randomly, as per intensivist's direction to pressure support mode (7-10 cmH_2O) with a PEEP of 5 cmH_2O, CPAP of 5 cmH_2O or directly to T Piece with 40% Venturi. The FiO_2 delivered via ventilator was 40%. The vitals were constantly monitored for any deterioration and warning signs of weaning failure. Mean arterial pressure, respiratory rate and arterial blood gas analysis to assess pH, PaO_2 and $PaCO_2$ were documented at 30 minutes and 120 minutes of trial wean. Patients who met extubation criteria and the spontaneous breathing trial for 120 minutes underwent an immediate extubation and received post extubation care such as nebulization, bronchial hygiene therapy, incentive spirometry, encouraged coughing etc. oxygen was supplemented via a facemask. The patients who were not tolerating spontaneous breathing trials were reinstituted on assist control mode or SIMV mode with pressure support. Extubated patients were constantly monitored for any adverse events and all vitals were charted. Deterioration in patient status/ warning signs were informed and appropriate actions including reintubations were performed. At 120 minutes post extubation, mean arterial pressure, respiratory rate and arterial blood gas analysis to assess pH, PaO_2 and $PaCO_2$ were again documented. Patients were on constant monitoring for the next 24 hours, to assess the success of extubation. All adverse events were dealt appropriately.

Statistical Analysis: Qualitative data were described by percentage distribution. Comparison of quantitave variables among three categories of weaning techniques were done by analysis of variance (ANOVA). There were 41 male (54.7%) and 34 female (45.3%) patients. The average age was 47.8±16.3 and age ranged from 19 to 74 years. Average age was 47.8±16.3 and age ranges from 19 to 74 years. 8.0% of the cases were in the age group of <25 years and 18.7 % were in >65 years of age group. Since the aim of the study was to evaluate the effects of different weaning criteria's, the datas were collected at 30 minutes and 120 minutes of initiation of trial and if extubated, 120 minutes post extubation reassessment of the same values again as described in the methodology. Reintubation cases in 24 hours of extubation were also noted. The analyzed parameters were: 1) Mean Arterial Pressure (mmHg). 2) Respiratory Rate (breathes per minute). 3) Ph. 4) PaO_2 (mmHg). 5) $PaCO_2$ (mmHg). 6) Extubation rate. 7) Reintubation rate.

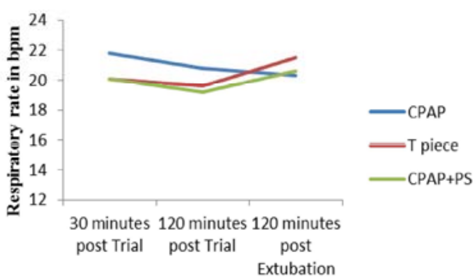
Comparison of Mean Arterial Pressure (MAP): Average MAP among CPAP, T piece and PS was 82.4 ± 7.6, 84.5±6.7 and 87.7±9.2 respectively at 30 minutes of Post SBT. MAP at 30 minutes post SBT were comparable among the three categories (p>0.05). Average MAP among CPAP, T piece and PS was 84.6 ± 8.8, 82.8 ± 8.6 and 84.1 ±16.7respectively at 120 minutes of Post SBT. MAP at 120 minutes post SBT were comparable among the three categories (p>0.05). Average MAP among CPAP, T piece and PS was 80.2 ±11.0, 85.6±9.5 and 85.7± 11.2respectively at 120 minutes of Post Extubation. MAP at 120 minutes post extubation were comparable among the three categories (p>0.05).

	CPAP		T piece		PS			
MAP	Mean	SD	Mean	SD	Mean	SD	F	P
30 minutes post SBT	82.4	7.6	84.5	6.7	87.7	9.2	2.19	0.12
120 minutes post SBT	84.6	8.8	82.8	8.6	84.1	16.7	0.1	0.9
120 minutes post Extubation	80.2	11.0	85.6	9.5	85.7	11.2	1.03	0.36



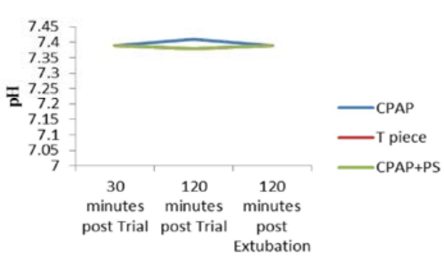
Comparison of Respiratory Rate (RR): Average RR among CPAP, T piece and PS was 21.8 ± 3.8, 20.1±3.2 and 20.1±3.4 respectively at 30 minutes of Post SBT. RR at 30 minutes Post SBT were comparable among the three categories (p>0.05). Average RR among CPAP, T piece and PS was 20.8 ± 4.7, 19.6 ± 4.2 and 19.2 ±5.1 respectively at 120 minutes of Post SBT. RR at 120 minutes Post SBT were comparable among the three categories (p>0.05). Average RR among CPAP, T piece and PS was 20.3 ±8.3, 21.5±4.3 and 20.6± 4.6 respectively at 120 minutes of post extubation. RR at 120 minutes post extubation were comparable among the three categories (p>0.05).

	CPAP		T piece		PS			
RR	Mean	SD	Mean	SD	Mean	SD	F	P
30 minutes post SBT	21.8	3.8	20.1	3.2	20.1	3.4	1.1	0.34
120 minutes post SBT	20.8	4.7	19.6	4.2	19.2	5.1	0.43	0.65
120 minutes post Extubation	20.3	8.3	21.5	4.3	20.6	4.6	0.33	0.72



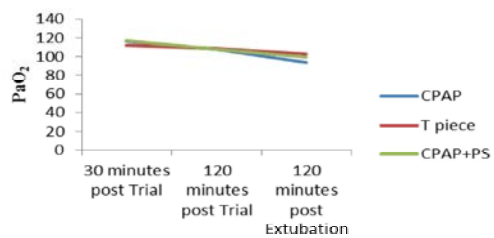
Comparison of pH: Average pH among CPAP, T piece and PS was 7.39 ±.03, 7.39±.03 and 7.39±.03 respectively at 30 minutes of Post SBT. pH at 30 minutes post SBT were comparable among the three categories (p>0.05). Average pH among CPAP, T piece and PS was 7.41 ±.05, 7.38 ±.04 and 7.38 ±.04 respectively at 120 minutes of post SBT. pH at 120 minutes post SBT were comparable among the three categories (p>0.05). Average pH among CPAP, T piece and PS was 7.39 ±.05, 7.39±.05 and 7.39±.04 respectively at 120 minutes of post extubation. pH at 120 minutes post extubation were comparable among the three categories (p>0.05).

	CPAP		T piece		PS			
pH	Mean	SD	Mean	SD	Mean	SD	F	P
30 minutes post SBT	7.39	.03	7.39	.03	7.39	.03	.043	.958
120 minutes post SBT	7.41	.05	7.38	.04	7.38	.04	1.681	.193
120 minutes post Extubation	7.39	.05	7.39	.05	7.39	.04	.012	.988



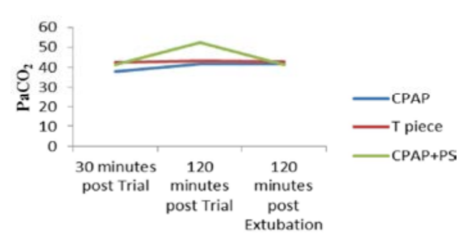
Comparison of PaO_2: Average PaO_2 among CPAP, T piece and PS was 116.5 ± 11.3, 112.3±15.4 and 117.3±11.8 respectively at 30 minutes of post SBT. PaO_2 at 30 minutes post SBT were comparable among the three categories (p>0.05). Average PaO_2 among CPAP, T piece and PS was 108.0 ± 10.7, 108.4 ± 15.1 and 107.9 ± 11.1 respectively at 120 minutes of post SBT. PaO_2 at 120 minutes post SBT were comparable among the three categories (p>0.05). Average PaO_2 among CPAP, T piece and PS was 93.7 ±6.8, 102.9±12.1 and 100.0± 9.7 respectively at 120 minutes of post extubation. PaO_2 at 120 minutes post extubation were comparable among the three categories (p>0.05).

	CPAP		T piece		PS			
PaO_2	Mean	SD	Mean	SD	Mean	SD	F	P
30 minutes post SBT	116.5	11.3	112.3	15.4	117.3	11.8	1.2	0.31
120 minutes post SBT	108.0	10.7	108.4	15.1	107.9	11.1	0.01	0.99
120 minutes post Extubation	93.7	6.8	102.9	12.1	100.0	9.7	2.64	0.08



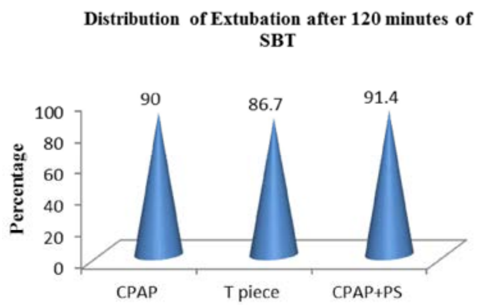
Comparison of $PaCO_2$: Average $PaCO_2$ among CPAP, T piece and PS was 38.0 ±12.4, 42.4±3.5 and 41.2±2.7 respectively at 30 minutes of post SBT. $PaCO_2$ at 30 minutes post SBT were comparable among the three categories (p>0.05). Average $PaCO_2$ among CPAP, T piece and PS was 41.6 ± 5.7, 43.2 ± 4.2 and 52.5 ±2.3 respectively at 120 minutes of post SBT. $PaCO_2$ at 120 minutes post SBT were comparable among the three categories (p>0.05).Average $PaCO_2$ among CPAP, T piece and PS was 41.7 ±7.1, 42.8±5.1 and 41.4± 3.9 respectively at 120 minutes of post extubation. $PaCO_2$ at 120 minutes post extubation were comparable among the three categories (p>0.05).

	CPAP		T piece		PS			
$PaCO_2$	Mean	SD	Mean	SD	Mean	SD	F	P
30 minutes post SBT	38.0	12.4	42.4	3.5	41.2	2.7	2.63	0.08
120 minutes post SBT	41.6	5.7	43.2	4.2	52.5	62.3	0.49	0.62
120 minutes post Extubation	41.7	7.1	42.8	5.1	41.4	3.9	0.64	0.53



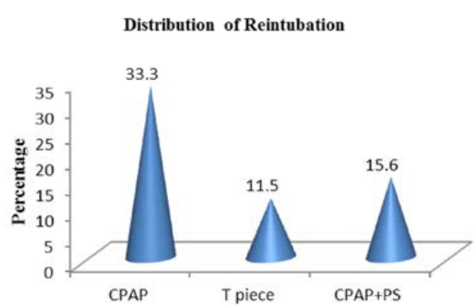
Analysis of Extubation: 90.0%, 86.7% and 91.4% of the CPAP, T piece and PS got extubated after 120 minutes of SBT respectively. The observed difference was not statistically significant (p>0.05).

Extubation after s 120 minute of SBT	Technique of wean CPAP N	%	T piece N	%	CPAP N	%	Total N	%
Yes	9	90	26	86.7	32	91.4	67	89.3
No	1	10	4	13.3	3	8.6	8	10.7
Total	10	100	30	100	35	100	75	100



Analysis of Reintubation: 33.3%, 11.5% and 15.6% of CPAP, T piece and PS group got reintubated in 24 hours. The observed difference was not statistically significant (p>0.05)

Reintubation	Technique of wean CPAP N	%	T piece N	%	CPAP N	%	Total N	%
Yes	3	33.3	3	11.5	5	15.6	11	16.4
No	6	66.7	23	88.5	27	84.4	56	83.6
Total	9	100.0	26	100.0	32	100.0	67	100.0



RESULTS

The analysis of successful extubation is done by percentage difference and is found to be comparable. The difference observed was not statistically significant (p>0.05). The arterial blood gas analysis variables (pH, PaO_2 and $PaCO_2$) during different time intervals (30 minutes of post SBT, 120 minutes of post SBT and 120 minutes of post extubation), were found to be comparable and were statistically not significant (p>0.05). Amongst the hemodynamic parameters, mean arterial pressure (MAP) during various time intervals (30 minutes of post SBT, 120 minutes of post SBT and 120 minutes of post extubation), were found to be comparable and were statistically not significant (p>0.05). The respiratory rate during different time intervals (30 minutes of post SBT, 120 minutes of post SBT and 120 minutes of post extubation), were also found to be comparable and were statistically not significant (p>0.05).

DISCUSSION

Mechanical Ventilation (MV) is commonly used as a life saving measure for patients suffering from various medical conditions that result in respiratory failure, as well as in post-operative recovery cases. Due to its numerous adverse effects, MV should be discontinued as soon as the patient can maintain spontaneous breathing with an adequate gas exchange [1,10-13]. Weaning or liberation from MV represents the period of transition from total ventilatory support to a spontaneous breathing. Different techniques can be used to wean patients from mechanically ventilation [1, 11, 12]. Successful, timely weaning and extubation has a considerable effect on the ultimate patient outcome [11, 12, 14, 15]. Weaning may be influenced by the underlying disease [12]. It is also understood, that the need for reintubation itself is also a marker of the severity of the underlying illness. From the available data in the literature review, the rate of reintubation ranges from 4 to 19 % [10, 12, 16]. The process of liberation or weaning depends on the clinician's judgment that a patient may be able to tolerate a reduction of ventilatory support [1, 10, 17, 18, 19]. At that point, there are several options for a decreasing support, some of which may be superior to others. The most popular method in practice is T-piece trial. Esteban *et al*. [17] compared 2 hours trial of unassisted breathing using PS of 7 cm H_2O vs. a T-piece. A smaller proportion of patients in the PS group (14 %) failed to tolerate the weaning and to achieve extubation at the end of the 2 hours trial than in the T-piece group (22 %). Of those patients who were extubated, 38 in the PS group and 36 in the T-piece group required a reintubation. The results of the second largest trial, by same author have suggested a possible advantage of PS over T-piece trial of spontaneous breathing. Esteban *et al*. [6] found that 22 % of 246 patients failed a T-piece weaning trial and of the 192 who were extubated, 19 % required a reintubation. Whereas another study of Jones *et al*. [20] found that only 4 % of 52 patients underwent weaning with T-piece trial were not extubated and of those who are extubated, only 4 % of 50 patients required reintubation. In another study, Esteban *et al.* [8] conducted a T-piece trial of an unassisted breathing in 546 patients and only 130 of had respiratory distress during a 2 hours T-piece trial. Brochard *et al* also found that a large number of patients have tolerated 2 hours T-piece trial of unassisted breathing and out of 456 patients who underwent the T-piece trial, only 109 had been unable to tolerate spontaneous breathing [7]. Vallverdu *et al.* [9] concluded that well supported 2 hours T-piece weaning had a favorable outcome in extubation of patients with COPD. Butler *et al*. [21] did not identify a superior weaning technique among the three most popular modes i.e. T-piece, PS and SIMV. In another study SBT was performed either using the T-piece and low level of pressure support with or without positive end expiratory pressure. It was observed that higher rate of failure occurred during the T-piece than during the pressure support trial, but once the patient had a success, the rate of reintubation was similar [22]. Many other studies have compared T-piece weaning with other modified techniques and generally had lower event rates. In many of these studies about techniques of weaning, the primary outcome observed was weaning failure and particularly the need for reintubation. While assessing the need for reintubation, the events like distress, morbidity factors such as pneumonia, lung injury and cardiac events and possibly death also has to be accounted [1, 10, 15, 23, 24]. In the setting of a high threshold and low failure rates, researchers would need to recruit large patient samples to demonstrate difference between the techniques [10, 15, 23, 24]. Such studies are unlikely to be feasible in a single setting and even if they are feasible, the resource consumption would be more. Thus, researchers interested in identifying the optimal weaning strategies should first establish reasonable events and if they are low, should reconsider initiation of trials comparing other alternate approaches.

CONCLUSION

From our study, it was observed that the parameters like mean arterial pressure, respiratory rate, pH, PaO_2, $PaCO_2$, rate of extubation and reintubations were comparable amongst pressure support (PS), continuous positive airway pressure (CPAP) and T-Piece group of patients. We could not identify a superior technique among the three most popular weaning modes i.e. T-piece, PS and CPAP. Now a days, new technologies like closed loop weaning systems, artificial intelligent weaning etc are proving to be useful in the enhanced weaning process. Though these technologies provide significant help in the process of weaning by automatically reducing the ventilator support and by indicating the optimal window to disconnect the patient from the ventilator, it should not replace the clinical criteria and clinical judgement regarding liberation process.

REFERENCES

1. Esteban, A., I. Alia, J. Ibanez, Benito s and M.J. Tobin, 1994. Modes of mechanical ventilation and weaning. A national survey of Spanish hospitals. The Spanish Lung Failure Collaborative Group. Chest, 106: 1188-1193.
2. Torres, A., J.M. Gatell, E. Aznar, M. El-Ebiary, J. Puig de la Bellacasa, J. González, M. Ferrer and R. Rodriguez-Roisin, 1995. Re-intubation increases the risk of nosocomial pneumonia in patients needing mechanical ventilation. Am J. Respir Crit Care Med., 152: 137-141.
3. Epstein, S.K., R.L. Ciubotaru and J.B. Wong, 1997. Effect of failed extubation on the outcome of mechanical ventilation. Chest, 112: 186-192.
4. Seymour, C.W., A. Martinez, J.D. Christie and B.D. Fuchs, (2004. The outcome of extubation failure in a community hospital intensive care unit: a cohort study. Crit Care, 8: R322-R327.
5. Coplin, W.M., D.J. Pierson and K.D. Cooley, D.W. Newell and G.D. Rubenfeld, 2000. Implications of extubation delay in brain-injured patients meeting standard weaning criteria. Am J. Respir Crit Care, Med., 161: 1530-1536.
6. Esteban, A., I. Alia and M. Tobin, A. Gil, F. Gordo, I. Vallverdú, L. Blanch, A. Bonet, A. Vázquez, R. De Pablo, A. Torres, M.A. De La Cal and S. Macías, 1999. Effect of spontaneous breathing trial duration on outcome of attempts to discontinue mechanical ventilation. Spanish Lung Failure Collaborative Group. Am J. Respir Crit Care Med., 159: 512-518.
7. Brochard, L. A., Rauss, S. Benito, G. Conti, J. Mancebo, N. Rekik, A.Gasparetto and F. Lemaire, 1994. Comparison of three methods of gradual withdrawal from ventilatory support during weaning from mechanical ventilation. Am J. Respir Crit Care Med., 150: 896-903.

8. Esteban, A., F. Frutos, M.J. Tobin, I. Alia, J.F. Solsona, I. Valverdu, R. Fernández, M.A. De la Cal, S.Benito and R. Tomás, 1995. A comparison of four methods of weaning patients from mechanical ventilation. Spanish Lung Failure Collaborative Group. N. Engl. J. Med., 332: 345-50.
9. Vallverdu, I., N. Calaf, M. Subirana, A. Net, S. Benito and J. Mancebo, 1998. Clinical characteristics, respiratory functional parameters and outcome of a two-hour T-piece trial in patients weaning from mechanical ventilation. Am J. Respir Crit Care Med., 158: 1855-62.
10. Meade, M., G. Guyatt and T. Sinuff, 2001. Trials comparing alternative weaning modes and discontinuation assessments. Chest. Dec; 120(6 Suppl): 425S-37S.
11. Mancebo, J., 1998. Weaning from artificial ventilation. Monaldi. Arch. Chest. Dis., 53(3): 350-354.
12. Epstein, S.K., 2009. Weaning from ventilatory support. Curr. Opin. Crit Care. 15(1): 36-43.
13. Frutos-Vivar, F., N.D. Ferguson, A. Esteban, S.K.Epstein, Y. Arabi, C. Apezteguía, M. González, N.S. Hill, S. Nava, G. D'Empaire and A. Anzueto, 2006. Risk factors for extubation failure in patients following a successful spontaneous bre-athing trial. Chest. 130(6): 1664-1671.
14. Epstein, S.K., 2002. Decision to extubate. Intensive Care Med., 28(5): 535-546.
15. Epstein, S.K., 2007. Weaning the "unweanable": liberating patients from prolonged mechanical ventilation. Crit Care Med., 35(11): 2640-2641.
16. Tomicic, V., M. Espinoza and M. Andresen, J. Molina, M. Calvo, H. Ugarte, J. Godoy, S. Gálvez, J.C. Maurelia, Delgado, I. Delgado and I. Esteban, 2008. Characteristics and factors associated with mortality in patients receiving mechanical ven-tilation. Rev. Med. Child, 136(8): 959-967.
17. Esteban, A., I. Alía, F. Gordo, R. Fernández, J.F. Solsona I. Vallverdú, S. Macías, J.M. Allegue, J. Blanco, D. Carriedo, M. León, M.A. De la Cal, F. Taboada, J. Gonzalez de Velasco, E. Palazón, F. Carrizosa, R. Tomás, J. Suarez and R.S. Goldwasser, 1997. Extubation outcome after spontaneous breathing trials with T-tube or pressure support ventilation. The Spanish Lung Failure Collaborative Group. Am. J. Respir. Crit. Care. Med., 156: 459-65.
18. Tanios, M.A., M.L. Nevins and K.P. Hendra, P. Cardinal, J.E. Allan, E.N. Naumova and S.K. Epstein, 2006. A randomized, controlled trial of the role of weaning predictors in clinical decision making. Crit. Care. Med., 34(10): 2530-2535.
19. Lellouche, F., J. Mancebo, P. Jolliet, J. Roeseler, F. Schortgen, M. Dojat, B. Cabello, L. Bouadma, P. Rodriguez, S. Maggiore, M. Reynaert, S. Mersmann and L. Brochard, 2006. A multicenter randomized trial of computer driven protocolized weaning from mechanical ventilation. Amer J. Resp. Crit. Care. Med., 174(8): 894-900.
20. Jones, D.P., P. Byrne, C. Morgan, I. Fraser and R. Hyland, 1991. Positive end-expiratory pressure vs. T piece. Extubation after Mechanical Ventilation. Chest. 100: 1655-1659.
21. Butler, R., S.P. Keenan, K.J. Inman, W.J. Sibbald and G. Block, 1999. Is there a preferred technique for weaning the difficult-to-wean patient? A syste-matic review of the literature. Crit Care Med., 27(11): 2331-2336.
22. Cabello, B. and J. Mancebo, 2007. Result of extubation after spontaneous breathing test with automatic tube compensation versus continuous positive airway pressure. Med. Intensiva, 31(7): 399-401
23. Epstein, S.K., 2006. Preventing postextubation respiratory failure. Crit Care Med., 34 (5): 1547-1548.
24. Epstein, S.K., 2004. Extubation failure: an outcome to be avoided. Crit Care, 8(5): 310-312.