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Indicators of Fatigue and of Prolonged Weaning from Mechanical Ventilation in Surgical Patients

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Abstract. Indicators of weaning success have been tested primarily in patients who have been ventilated for short periods of time, and they may not be as accurate in cases where support has been required for longer than a few days. In patients requiring longer periods of support it is difficult to estimate the likelihood of successful liberation. Therefore we evaluated established weaning indices for their accuracy in surgical patients who required ≥ 72 hours of mechanical ventilation. Surgical patients who required mechanical ventilation for ≥ 72 hours were prospectively followed (over 6 months). We obtained standard indices of ventilatory function daily once patients were ready to wean. These indices included the respiratory rate/tidal volume ratio (RSBI), the maximal inspiratory pressure, and the minute ventilation. The duration of weaning and explicitly defined episodes of fatigue were the outcomes of interest. Statistical analyses evaluated the multiple factors that might influence the duration of weaning. Ninety-five patients (66% trauma; 34% surgery) survived to begin weaning, and 93% were liberated. The median duration of mechanical ventilation prior to weaning was 4 days (range 3–16 days), and the median duration of weaning was 3 days (range 0–56 days). Fatigue occurred in 36 patients and was not reliably predicted by any of the weaning measurements. However, a RSBI of >105 on the first day of weaning was associated with prolonged weaning. By multivariate analysis, an RSBI of >105 on the first day of weaning predicted prolonged weaning (hazard ratio 1.9; $p = 0.03$). After 72 hours of mechanical ventilation, clinical fatigue and successful liberation are not reliably predicted by standard indices of respiratory muscle strength and reserve. However, an RSBI of >105 observed once the patient is ready to wean is associated with prolonged weaning.

Respiratory failure is the most common serious complication requiring intensive care following severe trauma, sepsis, and major surgery. In most cases the precipitating causes resolve quickly, and liberation from mechanical ventilation can proceed rapidly. In other cases a gradual reduction in support (weaning) is required, as the patient may be initially unable to tolerate the effort required to breathe spontaneously. Failure to identify patients who are capable of unsupported breathing may result in prolonged mechanical ventilation, whereas inappropriate withdrawal of support may result in respiratory muscle fatigue and overt failure. Both of these errors can exacerbate respiratory muscle fatigue, further prolong mechanical ventilatory support, and lead to potentially avoidable interventions and complications.

Objective measures to estimate a patient's ability to breathe without mechanical support have been developed, validated, and applied under varying clinical conditions. Measurements that have been tested and applied clinically to predict successful liberation include a spontaneous minute volume (Ve) of ≤ 10 L/min, a maximum inspiratory pressure ($P_i$max) ≤ −30 cmH_2O, and a tidal volume/respiratory rate ratio (rapid-shallow breathing index: RSBI) of ≤ 105 [1, 2]. When measured by explicit, consistent methods, the RSBI has been reported to be one of the best predictors of both weaning success and failure when compared to a number of other individual and composite measures [1]. A number of studies have confirmed these results, suggesting that the RSBI is a reliable measure for discriminating patients ready to be liberated from the ventilator from those unable to sustain unsupported breathing [3–5]. On the other hand, some reports have suggested that the RSBI is a less reliable instrument [6, 7].

The conflicting results in the existing literature do not necessarily indicate the lack of utility of the RSBI or other measures for estimating ventilatory capacity. Instead, they likely reflect the difficulties encountered when applying these measurements to a wide range of clinical situations. For instance, many studies examining various indices of respiratory and ventilatory capacity have included patients who have undergone mechanical ventilation for widely varying periods of time. It could be expected that individual and composite indices are more accurate in patients who have had relatively short courses of support. In cases of prolonged mechanical ventilation, these indices may be less accurate, and other factors (nutritional status) may contribute to weaning success or failure [8].

The notion examined here is that standard estimates of successful liberation from mechanical ventilation may be poor predictors of liberation or failure in critically ill or injured surgical patients who have required > 72 hours of mechanical ventilation. We hypothesized that an RSBI of > 105, a Ve of > 10 L/min, or a $P_i$max of > −30 cmH_2O do not reliably predict fatigue during weaning. We also hypothesized that successful liberation is not associated with a RSBI of ≤ 105, a Ve of < 10 L/min or a $P_i$max

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of ≤ -30 cmH_2O measured on the day of successful liberation. Finally, we also proposed to determine whether measurements obtained on the day readiness to wean criteria are first met (day 0) are useful for predicting prolonged weaning. Therefore we hypothesized that an RSBI ≥ 105, a $P_i$max of > -30 cmH_2O, and a Ve > 10 L/min measured on day 0 are not associated with prolonged weaning.

Methods

The Institutional Review Board at the University of Texas Southwestern Medical Center and Parkland Memorial Hospital approved patient enrollment in to this study. Informed consent was not required for this observational study. Patients admitted to our surgical and trauma intensive care unit (ICU) were prospectively followed once they had received mechanical ventilation for 72 hours and were not brain-dead. All patients meeting these initial entry criteria were examined daily by members of the Respiratory Care Department, and data were collected daily at 5:00 AM.

First, patients were screened for readiness-to-wean criteria, including resolution of the underlying disease process, no inotropic or vasopressor support, a PaO_2/FiO_2 (P/F) ratio of > 150, positive end-expiratory pressure (PEEP) ≤ 5 cmH_2O, and pH 7.30 to 7.50. Once these criteria were met, weaning parameters were attempted daily at 5:00 AM until the patient was successfully liberated from mechanical ventilation for > 24 hours. Measurements included Ve, $P_i$max, and the RSBI. All measurements were obtained manually, after disconnection from the ventilator for 30 to 60 seconds. If the patient did not breathe spontaneously, developed respiratory distress, or became hypoxemic ($SpO_2 < 90\%$) during any of the measurements, they were reconnected to the ventilator and the event noted on the data collection form.

The $P_i$max was measured at the end of the endotracheal tube with a pressure transducer equipped with a one-way exhalation valve. The $P_i$max was recorded as the maximum pressure generated after 20 seconds of airway occlusion [1]. The RSBI was calculated by dividing the respiratory frequency by the Vt (in liters) after 60 seconds of spontaneous breathing.

Failure or fatigue during weaning was defined by explicit criteria and was recorded by the respiratory therapist. These criteria included (1) $PaCO_2 > 50$ mmHg or an increase of > 10 mmHg; (2) $SaO_2 < 90\%$ or $PaO_2 < 60$ mmHg; (3) pH < 7.30; (4) heart rate > 120/min; (5) systolic blood pressure > 180 mmHg or < 90 mmHg; (6) respiratory rate > 30/min; and (7) clinical evidence of respiratory distress (diaphoresis, agitation, accessory muscle use) that did not resolve after a period of observation. One or more of these criteria, accompanied by an ordered increase in the amount of ventilatory support, was necessary to define an episode of failure.

In our ICU weaning proceeds under the direction of the attending surgical team and may follow an established protocol. The primary methods of weaning in our ICU are (1) a gradual reduction in pressure support ventilation and (2) decreases in synchronized intermittent mandatory ventilation rate. Daily trials of spontaneous breathing are incorporated at the discretion of the responsible surgical service. As we sought to identify only those episodes of fatigue that occurred during a gradual reduction in support, we did not include reintubation in our definition of fatigue. This allowed us to avoid the potential confounding effects of airway complications, such as airway edema and inability to clear secretions. Successful liberation was defined as > 24 hours of unassisted ventilation. Patients successfully liberated were not reenrolled if they developed subsequent episodes of respiratory failure requiring mechanical ventilation.

All clinical care was guided or directly provided by members of the primary surgical service, who had access to all the measurements obtained. The investigators did not make specific recommendations to the attending and resident staff based on the measurements obtained. Data were prospectively collected as part of the standard electronic record maintained by the Respiratory Care Department. Additional clinical information was prospectively collected and recorded daily. Data were subsequently downloaded or manually entered into a computerized database for storage and analysis. Actual values for the individual weaning parameters were recorded and converted to categoric variables based on threshold values from the existing literature. The RSBI was categorized as either > 105 or ≤ 105 for the purpose of our analyses. Similarly the $P_i$max was categorized as either > -30 cmH_2O or ≤ -30 cmH_2O, and Ve was categorized as ≤ 10 L/min or > 10 L/min.

Statistical analyses were performed using SPSS (version 9.0; SPSS, Chicago, IL, USA). Categorical variables are presented as proportions, and continuous data are presented as medians and the interquartile range. The specificity of the individual weaning measurements for fatigue was defined as the percentage of patients in whom the measurements predicted fatigue on the day an episode of fatigue actually occurred. Conversely, the sensitivity of each measurement for successful liberation from mechanical ventilation was based on the measurements recorded on the morning of successful liberation.

The log-rank test was used to compare the effect of individual categoric variables on the duration of weaning. The exact p values for these tests are reported. Multivariate analysis using the Cox proportional hazards regression was used to identify the factors associated with the duration of weaning. All variables that potentially contributed to prolonged weaning were evaluated in a stepwise regression procedure, and those with associated p values of ≤ 0.05 were included in the final model. The hazard ratio for the association between each variable and the duration of weaning are presented with their associated 95% confidence intervals.

Results

During the first 6 months of 1998, 95 patients were enrolled. Table 1 summarizes the demographic and baseline clinical information. The relatively young age reflects a large percentage of trauma victims (66%) in our study sample. The trauma victims tended to be slightly younger and were more likely to be male than the nontrauma patients. There were no differences between the trauma and nontrauma patients in terms of the duration of mechanical ventilation, survival, or the incidence of successful liberation.

Thirty-six patients met the definition of fatigue at least once after meeting readiness-to-wean criteria. Data regarding these patients and their initial episode of fatigue are presented in Tables 2 and 3. The median time from the time of meeting weaning criteria to clinical fatigue was 2.5 days; 75% of the patients experienced their first episode of fatigue within 7 days of meeting-readiness-to-wean criteria. The frequencies with which the individual criteria identifying fatigue were met are indicated in Table

Table 1. Demographic and baseline clinical information.

Parameter	Data
Age (years)[a]	47 (35–56)
Gender	
Male	63 (66%)
Female	32 (34%)
Duration of mechanical ventilation prior to meeting entry criteria (days)[a]	4 (3–16)
Duration of weaning (days)[a]	3 (0–56)
Survival	
Lived	89 (94%)
Died	6 (6%)
Clinical fatigue	
Yes	36 (38%)
No	59 (62%)
Successfully liberated	
Yes	88 (93%)
No	7 (7%)

[a]Median (95% confidence interval).

Table 2. Fatigue: 36 patients meeting fatigue criteria.

Parameters	Data
Duration of weaning prior to initial episode of fatigue (days)[a]	2.5 (0.25–7.5)
Fatigue criteria	
Hypoxia ($PaO_2 < 60$ mmHg, $SpO_2 < 90\%$)	11 (31%)
Hypercarbia ($PaCO_2 > 50$ mmHg)	9 (25%)
Pulse rate > 120/min	17 (47%)
Systolic blood pressure > 180 or < 90 mmHg	2 (6%)
Respiratory rate > 30/min	33 (92%)
Clinical respiratory distress	27 (75%)

[a]Median (95% confidence interval).

2. A respiratory rate > 30/min and other clinical evidence of respiratory distress were the most common findings, whereas hemodynamic instability and hypercarbia were the least frequent indicators. A spontaneous Ve of > 10 L/min had the highest specificity and a $P_i$max > −30 cmH_2O the lowest specificity for weaning failure.

Ultimately, 88 (93%) patients were liberated from mechanical ventilation; the median total duration of ventilatory support was 10 days. A $P_i$max of ≤ −30 cmH_2O was the most sensitive and a Ve of ≤ 10 L/min the least sensitive criterion for successful liberation. The sensitivity and specificity of each of these measurements are presented in Table 3. Of the 36 patients who met the criteria for fatigue, 31 were eventually liberated. In 46% of those who had an elevated Ve or RSBI on the day they initially fatigued, each index remained above its threshold value up to the time of liberation. Conversely, in patients who fatigued despite either a Ve of ≤ 10 L/min or an RSBI of ≤ 105, the Ve increased to > 10 L/min in 36% of cases and the RSBI increased to > 105 in 21% of cases by the time of successful liberation.

The RSBI measured on the day of meeting readiness-to-wean criteria (day 0) was associated with significantly prolonged weaning. The median duration of weaning patients with an RSBI of > 105 was 8 days compared to 2 days for patients with an RSBI of ≤ 105 (log-rank statistic 9.78, $p = 0.002$). In contrast, the log-rank test did not indicate a significant difference in the duration of weaning associated with the $P_i$max or Ve measured on day 0. Multivariate analysis that incorporated the other weaning indices, patient age, condition leading to respiratory failure, and duration of mechanical ventilation prior to weaning confirmed that only the RSBI, measured on day 0 was a significant predictor of the duration of weaning (hazard ratio 1.9; 95% CI 1.05−−3.04). A longer period of mechanical ventilation prior to meeting readiness-to-wean criteria was associated with a slight but nonstatistically significant difference in the duration of weaning (hazard ratio 0.95; 95% CI 0.88–1.03). The duration of weaning for the two groups based on the RSBI threshold of 105 is represented in Figure 1.

Discussion

Respiratory failure is the most frequent reason for prolonged stay in the ICU and the most common organ system failure in critically ill and injured patients. Moreover, the duration of mechanical ventilation is a direct determinant of costs in the ICU [9]. A relatively small but important group of patients require more than 2 to 3 days of mechanical ventilation. It has been estimated that 90% to 95% of patients who undergo mechanical ventilation (MV) can have this support discontinued within hours to 2 to 3 days; the remaining 5% to 10% of patients consume a disproportionate amount of ICU resources [10, 11]. In a cohort of patients with burns, 11% required MV for > 3 days, suggesting that in some populations a significant proportion of patients fall into the group of those potentially difficult to liberate [12]. Most studies do not specifically address this potentially important groups [13].

In their early description of the RSBI and other measurements. Yang and Tobin suggested that these measurements were less useful for predicting extubation success or failure in patients undergoing ≥ 8 days of MV [1]. However, that determination was based on an analysis of 20 subjects.

Our study was designed and conducted in an attempt to address specifically the role and utility of standard weaning measurements in patients with more than 3 days of ventilatory support. Our findings indicate that individual and combined measures of respiratory muscle strength and reserve may be less accurate when estimating the outcome of weaning after ≥ 72 hours of MV. Yang and Tobin reported that an RSBI of ≤ 105 was present prior to 97% of successful extubations (sensitivity), which was reduced to 88% in 20 patients who had undergone ≥ 8 days of MV. We report a lower sensitivity (80%) in our sample of 95 patients. Conversely, Yang and Tobin reported a specificity for the RSBI of > 105 for an extubation failure rate of 63%. We report a lower specificity (44%), using a definition of fatigue that excludes extubation failures. This lower specificity may be related to the differences in the definition of fatigue (failure) between the two studies, differences in study subjects, or differences in measuring weaning parameters. Our methods for measuring $P_i$max and RSBI are derived directly from theirs.

Other investigators have found the RSBI to be an excellent predictor of successful extubation in postoperative subjects ventilated for > 12 hours [5]. The few patients who had undergone MV for ≥ 3 days were not evaluated separately. In elderly medical patients the RSBI was reported to be a less sensitive but more specific indicator than we have reported [3]. This may be due to differences in the underlying conditions and patients in the studies.

It is possible that in the case of more prolonged support, primary respiratory factors may be of less importance for deter-

Table 3. Sensitivity and specificity of weaning measurements for estimating fatigue and successful liberation.

Fatigue		Liberation	
Measurement obtained on day fatigue occurred	Specificity for fatigue (%)	Measurement obtained on day of successful liberation	Sensitivity for successful liberation (%)
RSBI ($>$ 105)	44	RSBI ($\leq$ 105)	80
Ve ($>$ 10 L/min)	56	Ve ($\leq$ 10 L/min)	68
$P_i$max ($>$ -30 cmH_2O)	8	$P_i$max ($\leq$ -30 cmH_2O)	87

RSBI: rapid shallow breathing index; Ve: minute ventilation (spontaneous); $P_i$max: maximum inspiratory pressure.

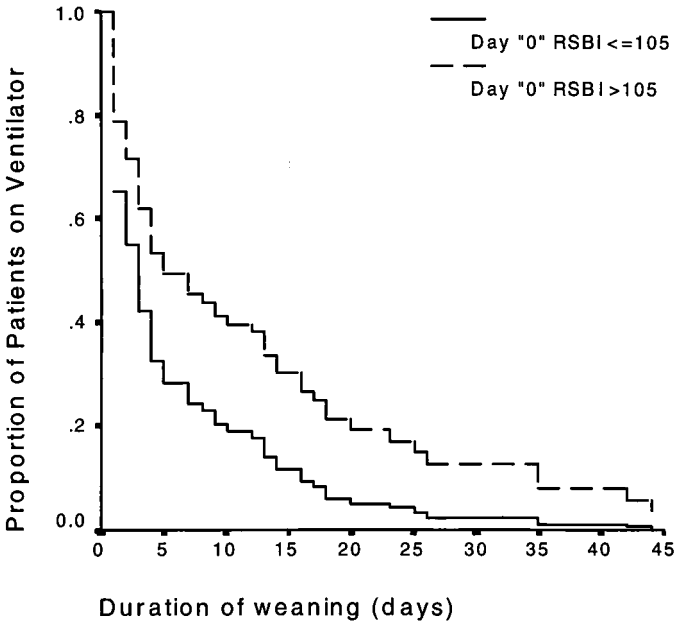

Fig. 1. Duration of weaning after meeting the readiness-to-wean criteria based on proportional hazards regression. The rapid shallow breathing index (RSBI) and duration of mechanical ventilation prior to meeting the readiness-to-wean criteria are included in the statistical model.

mining weaning success or failure. In 1984 Morganroth et al. reported that nonrespiratory factors were of considerable importance in determining the duration of weaning in a small cohort of 11 patients who had undergone MV for between 30 and 100 days. They reported that various respiratory factors, such as the spontaneous respiratory rate, $P_i$max, and Ve, did not change between unsuccessful and successful weaning periods [8]. In our study, the RSBI and Ve improved and crossed threshold values in only approximately 50% of the patients from the day fatigue occurred to the day of successful liberation. This findings suggests that improvement in ventilatory capacity as estimated by these measures may directly contribute to successful liberation in some patients. We do not have definitive information regarding the factors that may have contributed to these changes, but improved nutritional status, decreasing use of sedation, improving neurologic status, and diuresis are potential factors. An equal number of patients were ultimately liberated in whom weaning parameters not only did not improve but deteriorated, which likely reflects the importance of nonrespiratory determinants in a number of these patients.

Although not a good predictor of liberation within 24 hours, an RSBI of $\leq$ 105 measured once readiness-to-wean criteria are met indicates a high likelihood of rapid weaning. Patients with an RSBI of $\leq$ 105 on day 0 were liberated by a median of 2 days (interquartile range 1–4 days), and patients (35%) with an RSBI of $>$ 105 on day 0 had a median duration of weaning of 8 days (interquartile range 3–24 days).

Tobin and colleagues elegantly demonstrated that an increased respiratory rate and decreased tidal volume occurred almost immediately after beginning a trial of unsupported, spontaneous breathing in patients who ultimately failed the trial. This was in contrast to the stability of these measures in patients who completed the trial and were successfully liberated [14]. The development of a rapid and shallow breathing pattern ultimately led to CO_2 retention, without the development of significant hypoxia. The immediate development of this pattern of breathing suggests that it may not be simply a consequence of progressive fatigue but, rather, an indicator of an existing imbalance between ventilatory capacity and demand [15].

This observation represents the important and potentially useful finding of our work. First, attempts to wean and liberate patients after prolonged mechanical ventilation should be accompanied by efforts to improve modifiable nonrespiratory factors, such as overuse of sedation and narcotics and avoidance of abdominal distension. Other nonrespiratory factors such as nutritional status, cardiac disease, and fluid volume overload likely interact in a complex way with the pulmonary status and may prolong weaning by decreasing reserve or reducing pulmonary compliance. The conflicting conclusions reached by recent clinical trials comparing the impact of various techniques of weaning on the duration of mechanical ventilation suggests that nonrespiratory characteristics may be of critical importance for determining successful liberation [2, 16–18].

Second, the ability to discriminate between patients likely to be successfully liberated quickly (although not necessarily within 24 hours) from those who require a more prolonged weaning period (in our study 8 days versus 2 days) is of great practical importance. Although it has been suggested that conversion to tracheostomy may facilitate weaning, most existing reports are retrospective and subject to the significant limitations of such a study design [19, 20]. Unfortunately, the existing prospective trails are biased and difficult to interpret. The study by Rodriguez and colleagues was not truly randomized and was biased in favor of early tracheostomy, as patients who would have undergone late tracheostomy but were extubated before day 8 were not enrolled [21]. Therefore the groups being compared were markedly different at baseline, and the differences in duration of ventilation could be entirely explained by this design flaw. In another multicenter study, attempted randomization resulted in a marked imbalance in the

treatment group sizes (127 early tracheostomy/28 late tracheostomy), and they were unable to demonstrate any outcome differences between early and late tracheostomy [22]. By selecting patients likely to require a prolonged period of weaning, it may be possible to determine the appropriate timing for tracheostomy. Based on the RSBI measured once readiness-to-wean criteria are first met, patients expected to be extubated soon can be managed without tracheostomy. However, patients with a median estimated duration of weaning of 8 days may benefit from early tracheostomy. Selecting patients likely to require prolonged weaning would limit the use of tracheostomy and its associated complications.

Other investigators have attempted to estimate the need for prolonged MV using information available earlier in the course of respiratory failure. Seneff and colleagues, using data from the Acute Physiology and Chronic Health Evaluation (APACHI)III validation study determined that the duration of MV is associated with the admitting diagnosis and degree of physiologic derangement during the first 24 hours of support [11]. However, the complexity of their methods precludes prospective application to individual patients. Retrospective review of a cohort of trauma patients identified the Glasgow Coma Scale score on day 1, and the (A-a)O_2 gradient as predictors of the need for $>$ 14 days of mechanical ventilation [13]. Although some of the variables they examined are available for the trauma patients in our study, there are no comparable data for the non-trauma patients.

Other measures have been used to estimate fatigue and the likelihood of success during weaning, but they are less intuitive and not widely used. The tension-time index is a fairly complex measure based on the $P_i$max and inspiratory time. It does not have any clear advantage over the RSBI and other, simpler measures [4]. We did not obtain all the measurements of necessary to calculate this index. Direct measurement of the work of breathing (WOB) has been suggested as an important tool for quantifying the load on the respiratory system and adjusting the amount of support [23]. We measured the WOB in a small number of our patients and do not have sufficient data to include in our analyses. The widespread use of WOB measurements has likely not occurred because of the complexity of the methods (esophageal pressure monitoring) and the lack of demonstrated efficacy. One study has reported that the RSBI, measured during decreasing levels of inspiratory pressure support, correlated well with the directly measured WOB [24], whereas others have determined that the RSBI is not a good estimate of WOB [25]. Additional studies may be warranted to determine whether direct monitoring of the WOB provides any advantage over the clinical examination using the measurements discussed here.

Conclusions

The notable findings of our study are that the objective estimates of ventilatory muscle strength and reserve, including the RSBI, $P_i$max, and Ve, are less reliable indicators of fatigue or liberation in surgical patients who have undergone MV for 3 days or more. An RSBI $>$ 105 on day 0 indicates a high likelihood of prolonged weaning and may be an important tool for identifying patients likely to be difficult to wean and warrants careful attention to nonrespiratory factors. Additional research into the potential benefit of alternative airway management or weaning strategies is warranted in patients with an RSBI of $>$ 105 on the day of meeting readiness-to-wean criteria.

Résumé

Introduction: Jusqu'à présent, les indices pour prédire le succés du sevrage des patients ventilés ont été testés principalement chez les patients ventilés pour de courtes périodes; leur précision chez les patients nécessitant une ventilation prolongée est moins claire si bien qu'il est difficile d'estimer la probabilité de sevrage avec succés chez ce groupe de patients, Ainsi, nous avons évalué la précision des critères de sevrage chez le patient en chirurgie nécessitant 72 heures ou plous de ventilation artificielle. Patients et méthodes: Sur une période de 6 mois, les patients de chirurgie nécessitant une ventilation mécanique de 72 heures ou plus ont été suivis prospectivement. Nous avons relevé des indices standards de la fonction ventilatoire une fois par jour dés que le sevrage pouvait être envisagé. Ces indices comprenaient le rapport entere la fréquence respiratoire et le volume courant (RSBI), la pression maximale inspiratoire et la ventilation/minute. Les critères de jugement principaux ont été la durée du sevrage et des épisodes de fatigue. L'analyse statistique a évalué les facteurs, multiples, qui auraient pu influencer la durée de la période du sevrage. Résultats: Parmi 95 patients survivants (traumatismes: 66%, chirurgie: 34%), candidats au sevrage, le taux de succès a été de 95%. La durée médiane de ventilation mécanique avant le sevrage a été de 4 jours (extrêmes 3–16) et la durée médiane de la période de sevrage a été de 3 jours (extrêmes 0–56). Parmi les 36 patients qui ont présenté une fatigue musculaire respiratoire, aucun des critères n'a pu prédire aved fiabilité le succès ou l'échec du sevrage. Un rapport RSBI de $>$ 105 au premier jour de sevrage était associé à une période de sevrage prolongée. En analyse multivariée, un rapport RSBI supérieur à 105 au premier jour a significativement prédit une période de secrage prolongée (hazard ratio = 1.9; p = 0.03). Conclusions: Après 72 heures de ventilation mécanique, la fatigue musculaire clinique et un succès de sevrate ne sont pas prédits avec fiabilité par les indices standards de force musculaire et de réserve respiratoires. Cependant, un rapport RSBI supérieur à 105, observé lorsque le sevrage paraît réalisable est prédictif d'une période de sevrage prolongée.

Resumen

En un principio y en pacientes sometidos a ventilación mecánica de corta duración se establecieron los parámetros que permitían desconectar con éxito a dichos pacientes; la exactitud de estos indicadores no es tan precisa cuando los pacientes requieren ser ventilados various días. En pacientes sometidos a ventilación mecánica durante largos periodos de tiempo es dificil determinar cuando pueden ser desconectados con éxito. Por ello, valoramos los diversos índices establecidos para evaluar los que son más fiables y precisos para la desconexión de pacientes que requirieron una ventilación mecánica $\geq$ 72 horas. Pacientes y métodos: Durante 6 meses se efectuó un seguimiento prospectivo de todos aquellos enfermos quirúrgicos que precisaron ventilación mecánica $\geq$ 72 horas. Diariamente, una vez que los pacientes estaban preparados para la desconexión, obtuvimos los índices estándar de la función ventilatoria, que incluyen: el cociente entre la frecuencia respiratoria y el volumen tidal (RSBI), la presión

inspiratoria máxima y la ventilación minuto. Los resultados más interesantes se refieren a la duración de la desconexión y a los episodios bien definidos de fatiga respiratoria. Los análisis estadísticos demuestran que son múltiples los factores que pueden influenciar la duración del tiempo de desconexión. Resultados: 95 pacientes (66% traumatizados, 34% quirúrgicos) sobrevivieron el incio de la desconexión y en el 93% de elos se logró una desconexión definitiva. La duración media de la ventilación mecánica, antes de iniciar la desconexión, fue de 4 días (rango 3–16) y la duración media del tiempo de desconexión fue de 3 días (rango 0–56). 36 Pacientes presentaron fitiga respiratoria, sin que existiese indicador fiable predictivo alguno. Sin embargo, un RSBI $>$ 105 en el primer día del intento de desconexión se acompañó de un mayor tiempo de duración de la misma. El análisis multivariante demostró que un RSBI $>$ 105, el primer día del incio de la desconexión implica un tiempo de desconexión más prolongado (cociente de azar = 1.9; p = 0.03). Conclusiones: Tras 72 horas de venilación mecánica la fatiga clínica y una desconexión total con éxito no se puede predecir mediante los indices estándar que miden la potencia y la reserva de los músculos respiratorios. Por el contrario, un RSBI $>$ 105 cuando el paciente está preparado para ser desconectado se asocia a unperiodo de desconexión más prolongado.

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