Oxygen Consumption: Another Key Component in Predicting Ventilator Weaning Success

To the Editor:
I read with great interest the article by Bellani et al. and praise their important work in the field of weaning from mechanical ventilation. More than anything, I question how the authors formed the hypothesis that oxygen consumption (VO₂) increases more in patients unable to sustain decreasing ventilatory assistance. In a landmark article by Jubran et al., weaning failure was associated with increased oxygen extraction and decreased oxygen delivery. In the same article, the measured VO₂ increased in both the success and failure from weaning groups, with a lower increase in the success group. In contrast, Zakynthinos et al. demonstrated that patients who cannot be weaned have one of two hemodynamic and oxygen use profiles. (1) Those who fail without increasing VO₂ demonstrate increased oxygen extraction and decreased oxygen delivery. In the same article, the measured VO₂ in the failure group were significantly higher than in the success group (P < 0.05). (2) The authors further analyzed the group and pressure support effects on patients’ successive VO₂ data. By analysis of covariance (cited as a two-way ANOVA by the authors), significant differences were found in both the group and pressure support effects at P < 0.001. Accordingly, the authors concluded that the patients able to successfully complete their weaning trials were those who reacted to the decrease of ventilatory assistance with a greater increase in VO₂.

A paradox exists between these two results. The statistical values increased significantly after the analysis of covariance. With an increasing P value, their analysis of covariance model probably omitted the patients’ effects. In other words, they probably treated a patient’s successive VO₂ data (these data were related) as independent VO₂ data from different patients. Thus, their statistical values reached levels of less than 0.001 in such a small-group study (16 patients in the success group and 12 in the failure group). This criticism seems reasonable, especially after considering the diverse VO₂ trend patterns in response to the withdrawal of pressure support (as shown in their second figure). The diverse patterns would add complexity to the determination of the pressure support effect and should decrease, rather than increase, the statistical significance.

Another statistical issue is that the authors used a correlation coefficient to access the reproducibility of VO₂ measurements. The correlation coefficient is misleading. The Bland–Altman analysis is much more appropriate for assessing reproducibility.

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(Accepted for publication January 19, 2011.)
In conclusion, the authors produced an impressive and interesting study. However, after rechecking their statistics, it is clear that too many conclusions were drawn from the limited results.

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In Reply:
We thank Bloomstone for his interest in our article and for his comments. We entirely agree with him when he states that the weaning process is complex, multifactorial, and highly variable; this is also outlined in the editorial that accompanied our article. Our original hypothesis was that oxygen consumption (VO₂) would increase more in patients unable to sustain the weaning effort; this hypothesis was probably simplistic and did not account for some literature data, such as those published by Zakynthinos et al. On the other hand, we relied on solid evidence in the literature showing how increased VO₂ during weaning would be associated with failure. Moreover, Bloomstone wisely underlines how VO₂ is linked to the complex interplay between peripheral extraction and delivery. Unfortunately, as we acknowledge in the discussion of our article, the lack of assessment of the hemodynamic changes in our patients stands as a relevant limitation of our work.

We appreciate Chen’s deep attention in revising our data. In his sharp comment, he notes a paradox between the results of the Student t test and those of the ANOVA. However, the two tests are difficult to compare because they are performed on different sets of data. In fact, Chen neglects the fact that, although the minimum VO₂ readings were compared as absolute values using the Student t test, the ANOVA is performed after normalization of VO₂ by the minimum VO₂ reading of each patient. This normalization is expected to decrease the betweensubject heterogeneity in the "absolute values" of VO₂, causing the observed increase in statistical significance. Moreover, at variance from figure 2 of the original article, using ANOVA, the levels of pressure support are expressed as difference from the "resting" level of pressure support, rather than as absolute values; in other words, all patients are "aligned" on the x-axis, with the minimum recorded VO₂ corresponding to the same level of pressure support. We agree with Chen regarding the appropriateness of Bland–Altman analysis to evaluate the reproducibility of VO₂ measurement. Because this was not included in our original article, we report it herein: the mean difference between the minimum VO₂ value during the decremental pressure support trial and the VO₂ during the resting phase was 14 ml/min (95% CI, 61 to –33 ml/min).

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Accepted for publication January 19, 2011.