Intensive Care Med (2004) 30:744–745
DOI 10.1007/s00134-004-2214-8

EDITORIAL

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Breath by breath, spontaneously or mechanically supported: lessons from biphasic positive airway pressure (BIPAP)

Accepted: 2 February 2004
Published online: 2 March 2004

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Although biphasic positive airway pressure (BIPAP) has now been available for about 15 years [1], today its role in mechanical ventilation remains a matter of discussion. In part, the reason for this ongoing debate is given by the wide range of potential uses of BIPAP covering most situations requiring mechanical ventilatory support, i.e. from (pressure-)controlled ventilation up to partially assisted spontaneous breathing [2, 3]. Briefly, BIPAP is a universal *technique* of mechanical ventilation theoretically able to support various therapeutical *concepts* rather than a ventilation mode only based on a single strategy.

Hence, in the past years a considerable number of scientific articles on the most characteristic and unique feature of BIPAP, i.e. its particular way of supporting unrestricted spontaneous breathing throughout the mechanical ventilatory cycle [4, 5, 6, 7, 8, 9, 10], have been published emphasizing a variety of the most important properties of the BIPAP mode. In this issue of *Intensive Care Medicine* a further article dealing with the interaction between BIPAP ventilation allowing preserved spontaneous breathing and gas exchange and circulatory functions, respectively, in a lung injury model is presented by Henzler and colleagues [11]. Briefly, the authors compared respiratory and circulatory parameters (ventilation/perfusion ratio, cardiac output and oxygen delivery) during BIPAP with preserved spontaneous breathing and pressure-controlled ventilation. The latter mode was tested twice: with the same time and pressure settings as during BIPAP and after adapting inspiratory pressure to achieve the same *transpulmonary* pressure as with BIPAP. The results of the experiment revealed similar effects of BIPAP and pressure-controlled ventilation using equal transpulmonary pressure on ventilation/perfusion distribution and pulmonary oxygenation. However, as a result of the different airway pressure conditions, cardiac output and oxygen delivery were less depressed and—in consequence—higher during BIPAP ventilation with preserved spontaneous breathing.

Just considering this actual experiment together with the previous data on the effects of spontaneous breathing during BIPAP ventilation emphasizes major merits of the authors involved in these works. In fact, excellently dealing with sophisticated experiments they were able to show details on the effects of combining spontaneous breathing and mechanical ventilation [12, 13]. These are the lessons we have learned from BIPAP so far, which do not just tell us that spontaneous breathing "is better" than purely passive mechanical ventilation because it is "more physiologic", but which give us a more precise idea on how and to what extent spontaneous breathing may indeed contribute in maintaining normal physiological functions.

Nevertheless, important questions on the role of (BIPAP-sustained) spontaneous breathing in ventilated patients still arise; the first one is almost obvious and is mentioned by the authors of the current article: what is the clinical relevance with special respect to patient outcome or to an actually discussed "ventilator-associated lung injury"? Obviously there is no answer to these questions yet and these topics deserve further research. Furthermore, the data presented suggest how cautious predictions should be made even with regard to the short-term effects of spontaneous breathing. In fact, the actual experiment apparently failed to confirm the subtle benefits on pulmonary gas exchange previously obtained by using BIPAP with preserved spontaneous breathing, presumably due, at least in part, to the relatively large changes in hemodynamics induced by the specific ventilator settings used with the different experimental conditions. Hence, some at first glance unexpected and thus unpredictable effects may result from the well-known and complex interactions between mechanical ventilation and circulation (and other organs function, too).

The second question to be asked is as important as the first one: are the effects of combining spontaneous breathing and mechanical ventilation during respiratory support generic features, i.e. can the benefits obtained by combining spontaneous breathing with BIPAP also be achieved with other support modes, especially with pressure support ventilation? First of all we have to consider the data available to date: in fact, Putensen et al. compared BIPAP and pressure support ventilation and they clearly found that the latter mode failed to produce the same spontaneous breathing-related benefits obtained by BIPAP [6, 8]. However the question remains why the combination of spontaneous breathing and mechanical ventilation has apparently a different impact on physiological functions depending on which support mode is used. Indeed, there is a substantial difference between the different modes: with pressure support, each spontaneous breath is simultaneously supported by the ventilator. With BIPAP, in contrast, mechanical support is not as strongly synchronized with the spontaneous breaths, i.e. with BIPAP unsupported spontaneous breaths are allowed by the ventilator. This difference is reflected by data which demonstrated that (1) work of breathing is slightly increased with BIPAP when compared to pressure support (under comparable conditions regarding airway pressure settings and minute ventilation) [14] or that (2) esophageal pressure is lower with BIPAP than with pressure support [6], again under comparable conditions. Both results apparently confirm that spontaneous breathing activity is indeed higher with BIPAP than with pressure support, well in agreement with the technical properties of both modes. However, one should keep in mind that these results also depend on which support settings are chosen with both modes, e.g. how "comparable conditions" are defined.

In summary, by using BIPAP we learned how unrestricted spontaneous breathing works during mechanical ventilation and which benefits we may achieve. Furthermore we saw that, under specific conditions, those benefits achieved by BIPAP cannot be reproduced by pressure support ventilation. However, we still do not know whether appropriately adjusting pressure support in a way to support the patient sufficiently and simultaneously allowing an adequate condition of spontaneous breathing activity comparable to BIPAP would eventually result in the same benefits with regard to gas exchange or hemodynamics as observed with BIPAP.

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