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EDITORIAL

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Weaning from mechanical ventilation. When paediatric intensive care medicine profits from adult experience and vice-versa

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Weaning from mechanical ventilation is a field where our knowledge has not only expanded but also has moved from an area of clinical skills to a detailed understanding of pathophysiological mechanisms, and more recently from definitions of therapeutic strategies to clinical trials [1, 2, 3]. This phase of the whole mechanical ventilation process has been a subject of great interest because it was soon identified as the more likely to be modified, optimised and shortened by a scientific approach. For a long time no systematic approach was proposed in the literature for when and how to separate patients from the ventilator, and weaning was more often viewed as an art than a science.

One of the key features of the modern approach to weaning is the spontaneous breathing trial to assess a patient's ability to breathe without ventilatory support. For instance, in adult patients ventilated with volume-controlled ventilation, a sophisticated assessment of respiratory mechanics gives almost no hint as to how to distinguish patients who are going to pass a weaning trial successfully from those who are going to fail [4]. Similarly, indexes of oxygenation are generally very poor predictors of the ability of a patient to be separated from the ventilator. The best test, therefore, consists in allowing a short (up to 2 h) spontaneous breathing trial, the tolerance of which is an indicator of the possibility to separate the patient from the ventilator. This clinical evaluation is the most important, and often, the only consideration in the decision to extubate a patient, which might also depend on the assessment of upper airway function, level of consciousness and ability to expectorate.

In this issue of the journal, Farias et al. compared two methods to perform a spontaneous breathing trial before extubation in 257 paediatric intensive care patients deemed ready to undergo such a trial. The median age of the patients was 10 months in one group and 12 months in the other. In a randomised controlled trial, the authors compared a breathing test lasting up to 2 h, either with a T-piece or with pressure support ventilation at a level of 10 cmH_20. They found that the number of patients who successfully passed the trial and were extubated (79.2 % in the pressure support group and 77.5 % in the T-piece group), the number of re-intubations (15.1 % vs 12.7 %) and the number of patients who remained extubated for 48 h after the spontaneous breathing trial did not differ between the two groups. The authors have to be commended for performing such a large randomised controlled trial that provides important information for clinical practice. This study deserves some comments, especially when comparing the adult approach to weaning and the paediatric approach described in this study.

This study is more or less a replication – adapted to infants – of a study conducted in adult patients by Esteban et al, comparing a level of 7 cmH_20 of pressure support to the traditional T-piece trial [5]. A similar performance of the two types of tests was found by Esteban et al. The number of patients who successfully passed the initial spontaneous breathing trial was slightly and significantly better with pressure support, but no significant difference existed at 48 h after extubation. Whereas the two studies were performed in different populations and with different levels of pressure support, the results are, thus, very similar. It is difficult to know how precise the recommendation for the level of pressure support to be used should be, but in the two studies the similarity with the results of the T-piece trial helps to solve a debated issue.

In adult patients, indeed, various levels of pressure support have been advocated to compensate for the added work of breathing and to mimic the post-extubation work of breathing [6, 7]. In addition, some studies found that the work of breathing performed with low levels of pressure support was lower than after extubation [7, 8]. In a careful assessment of pre- and post-extubation work of breathing, Straus et al. showed that a T-piece trial well mimicked the post-extubation work of breathing in patients successfully extubated [9]. In other terms, the endotracheal tube (if correctly sized to the patient) does not need to be compensated per se, since the sum of the supra-glottic and glottic resistance plus the tracheal resistance are close to the impeding-flow characteristics of the endotracheal tube. Pressure support is therefore needed to compensate for the extra work imposed by the ventilator circuit, including the triggering valves and the circuit dead space. The pressure level needed may differ with the characteristics of the ventilator, but also with the breathing pattern of the patient. Theoretically, an individual assessment of the optimal pressure support level needed could be envisaged, but this would certainly render the use of such a simple weaning test more complex and less feasible. It is fortunate that two clinical trials, one in adults [5] and one in infants [10], allows the clinician to introduce a number directly into clinical practice, whereas physiological studies had not provided a definite "clinical" response. In the study by Farias et al. the level of pressure support used was quite arbitrary selected, but was initially derived from the literature, especially the adult experience and the personal experience of the authors.

Using pressure support for the spontaneous breathing trial may be interesting in the clinical arena because it may facilitate the weaning process. In the patient already ventilated with a ventilator offering this mode of ventilation, disconnection is avoided and preparation of a humidified T-piece circuit is unnecessary. In addition, the monitoring of respiratory parameters is easily performed during this critical period, thanks to the sensors of the ventilators, and the level of oxygenation is easily controlled. Because of these different aspects, performing spontaneous breathing trials with PS may be easier for the personnel than with a T-piece, although this has not been demonstrated. In an important study, Ely et al. demonstrated how crucial the performance of a spontaneous breathing trial was for shortening the duration of mechanical ventilation [3]. In a further study the same group, however, also showed that the large scale clinical implementation of such a simple weaning protocol was difficult and how frequently, for instance, ordered spontaneous breathing trials were not performed [11]. Every aspect that could simplify the approach to weaning from mechanical ventilation without increasing the risks associated with the procedure is, therefore, welcome.

A re-intubation rate of 10–15 % or so is consistently found among adult studies and is interestingly confirmed in the present paediatric study. Similar to many studies in adults, it is striking to note the high mortality rate associated with extubation failure in infants [5, 12, 13]. In the study by Farias et al. intensive care unit mortality was below 5 % in the two arms for successfully extubated patients, whereas it reached 40–45 % in the patients who needed re-intubation. From studies performed in the adult population, re-intubation seems to be independently associated with mortality [12, 13]. The more likely explanation is that the need for re-intubation identifies a subgroup of severely disabled patients who cannot be separated from ventilatory support more than on a short-term basis. Whether this requires modifying our approach to extubation is not known and needs further work both in the adult, and the paediatric population. Causes for re-intubation are frequently different from causes of inability to be separated from the ventilator, and include upper airway dysfunction, inability to remove secretions and subsequent aspiration [12]. One specific adult group at particular risk of re-intubation are patients with neurological disorders [14]. Appropriately designed tests to predict re-intubation, upper airway dysfunction and ability to cope with secretions are needed to reduce the re-intubation rate [15].

This study is an interesting illustration of how paediatrician and adult intensivists can collaborate and profit from the experience of the other. Too often, differences observed among the modes of ventilation and the strategy used in adult and in paediatric intensive care are explained by cultural habits and do not rely on a strong scientific background. In this era of evidence-based medicine, both approaches need to be challenged. For many years pressure-targeted modes of ventilation were routinely used in neonates whereas such modes have often been considered as a strange way to ventilate adults. Now, pressure support ventilation, widely used in adults, is becoming popular also for use in children. Understanding the limitations of the different modes in the two populations will benefit both adult and paediatric patients. For instance, specificity of paediatric ventilation includes the problem of the large instrumental dead space [16], the need to limit lung pressures to reduce the incidence of bronchopulmonary dysplasia and the concern for oxygen toxicity. No doubt all these aspects are now considered of paramount importance in adult ventilation, where reduction of pressures and volumes has been definitely proven to reduce mortality.

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