Sigh Breaths for Trauma Patients Receiving Mechanical Ventilation
Take a Deep Breath
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Occasionally, newspapers report positive stories of animal species believed to be extinct, only to be discovered alive and repopulating their habitats.1 In this issue of JAMA, Albert and colleagues2 assessed the role of sigh breaths in ventilated trauma patients at risk of acute respiratory distress syndrome. Though sighs did not result in a significant improvement in the primary outcome, they were well-tolerated and were associated with an improvement in some clinical outcomes. The sigh, believed to be extinct, is back. In 1976, Fairley3 declared that, “The mechanical ventilation sigh is a Dodo” (the dodo is an extinct flightless bird). Despite this statement, sighs survived in the clinical practice of several centers and were the subject of substantial clinical research.4-6 Importantly, they also remained a viable option in various commercial ventilators.

In respiratory physiology, the term sigh refers to a deep breath, often exhaled in sorrow, normally a complement to spontaneous breathing patterns, that is taken once every few minutes to maintain lung volume and avoid atelectasis.7 The sigh, in other words, keeps alveoli open that might otherwise close or reopens alveoli that had collapsed. As such, the sigh breath is sometimes considered a recruitment maneuver, albeit not falling under the prolonged high-pressure type.8 The physiologic importance of the sigh was brought to the attention of anesthesiologists in the early 1960s, as a necessary maneuver to maintain oxygenation and lung compliance during mechanical ventilation in patients undergoing anesthesia.9

In the following years, prolonged mechanical ventilation was established as a lifesaving procedure in acute respiratory failure. Soon, physicians were led to use high tidal volumes (10-15 mL/kg actual body weight), once again to preserve lung volume, compliance, and oxygenation. It is likely that the use of high tidal volumes, coupled with the widespread use of positive end-expiratory pressure (PEEP), consigned sighs to the background—the large volumes and high positive pressure splinted the lung open, without need for additional recruitment via sigh breaths. In Fairley’s editorial,3 he recommended, “In patients with normal lungs, each tidal volume should be large. In those with acute pulmonary failure, PEEP (to maximum compliance) should be used. Sighs, superimposed upon this, are likely to damage the lungs. The sigh is dead.”

In the following 2 decades, the concept of ventilator-induced lung injury was developed in diverse experimental and clinical settings; tidal volumes were lowered, and eventually the National Institutes of Health–sponsored ARMA trial demonstrated that using a tidal volume of 12 mL/kg ideal body weight instead of 6 mL/kg was associated with a substantial increase in mortality.10 With the use of lower tidal volumes, the old, intermittent inflation method, called sigh, regained interest and credibility in ventilatory management.11 Indeed, sigh became the focus of several studies that led to a better understanding of its physiologic effects.12 Among other studies, our group showed that the application of sighs allows the use of a lower PEEP at constant tidal volume, maintaining lung volume, oxygenation, and hemodynamics.4

Still, concerns were often raised about the possibility that sighs increased the risk of barotrauma and ventilator-induced lung injury. Reassuringly, a randomized clinical trial, designed to test the noninferiority of ventilation including sighs compared with standard-pressure support ventilation, proved that the procedure was feasible and safe when applied within the proposed limits of pressure and volume.5

The parameters selected by Albert and colleagues2 for the sigh maneuver are particularly conservative: sighs were delivered over 5 seconds once every 6 minutes and produced a plateau pressure of 35 cm H2O. This is substantially different from other more aggressive recruitment maneuvers. As a capital example, the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART)13 published in JAMA that tested prolonged (several minutes) recruitment maneuvers using plateau pressures as high as 50 cm H2O showed increased mortality. The latest international guidelines8 recommended strongly against prolonged maneuvers and suggested against the routine use of even short maneuvers (pressure >35 cm H2O, lasting <1 minute). In other words, do not sigh.

In the current study, Albert and colleagues did not focus only on patients with acute respiratory distress syndrome, but on patients with milder degrees of hypoxemia, as the mean PaO2/FiO2 ratio of 348. This study population led them to investigate a prophylactic, rather than therapeutic, application of sigh, which, likely by avoiding the development of atelectasis and maintaining a more homogeneous lung, reduced the progression of respiratory failure. Indeed, patients with PaO2/FiO2 ratio greater than 300 seemed to benefit the most from sigh application. The study focuses attention on the potential for deep breaths to release surfactant in the distal airways, preventing lung collapse, maintaining compliance, and stabilizing the terminal airways.14

At variance with the pediatric environment, the administration of surfactant as a treatment for acute hypoxemic respiratory failure in adult patients has not been demonstrated to be effective.15 Nevertheless, the physiologic role of the surfactant in maintaining normal aeration and ventilation is unequivocally proven and accepted.
This was a pragmatic trial, and the authors should be congratulated for their significant effort in conducting such a complex study, despite limited resources. The primary target, an increase in ventilator-free days, failed to reach statistical significance, while the secondary improvement in survival needs further confirmation. Still, considering the enormous importance of bedside physiology in understanding the disease mechanisms and therapy effects, readers may be left unsatisfied by the lack of physiologic variables recorded by the study. It is important to understand why sigh ventilation, which improves oxygenation, improved outcomes. For example, we could speculate that PEEP and FiO₂ may have been managed differently in the 2 study groups (lower PEEP and FiO₂, in the sigh group?), which might have contributed to a better outcome. This effect might have been mediated by other variables, such as hemodynamics and fluid balance. Therefore, we could conclude that sighs decrease the duration of ventilation, but the precise mechanism remains unknown. It is, therefore, of the utmost importance to further investigate the possible beneficial effect of sighs and the surfactant release into the terminal airways of mechanically ventilated patients.

Moreover, physiologic data, meticulously collected in the standardized context of other randomized trials, become resources that, if properly explored, may yield important evidence beyond the scope of the original trials. Examples include the prognostic value of driving pressure and the association between phenotypes and the effect of PEEP adjustment on outcomes.

In line with the PROTECTION study, the SiVent investigators do not report a higher incidence of adverse events associated with the application of sighs, providing reassurance regarding the possibility of safely conducting further research on this topic. However, unlike other ventilatory strategies (eg, low tidal volumes, higher PEEP levels), sigh cannot be universally offered to all ventilated patients because it is not available on all ventilator brands or models. The decision on whether and how to implement the innovations emerging from clinical research lies with the industry. In making this decision, clinical evidence is just one of several factors considered, alongside commercial, regulatory, and intellectual property considerations.

In conclusion, this study by Albert and colleagues brings back the focus on a simple and inexpensive tool. Although failing to demonstrate an unambiguous improvement in the primary outcome, their trial provides reassurance that the sigh, at least in this patient population, appears to be safe and possibly beneficial. Sighs, and recruitment maneuvers in general, deserve further scrutiny to better understand their limits, mechanisms, and indications in individual patients.

**REFERENCES**

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