

Adaptive Support Ventilation: An Inappropriate Mechanical Ventilation Strategy for Acute Respiratory Distress Syndrome?

To the Editor:

Adaptive support ventilation (ASV) allows clinicians to set a maximum plateau pressure (PP) and a desired minute ventilation. Thus, ASV automatically determines the respiratory rate and tidal volume (V_T) based on its algorithms and hereto adjusts V_T to keep PP below the set maximum. In a lung model with varying mechanics, all mimicking acute respiratory distress syndrome (ARDS), Sulemanji *et al.*¹ compared ASV with conventional mechanical ventilation with a fixed V_T of 6 ml/kg. Maximum airway pressure limit was 28 cm H₂O in ASV. The major finding was that ASV “sacrifices” V_T and minute ventilation to maintain PP in some scenarios (*i.e.*, V_T was <6 ml/kg, and minute ventilation was lower than desired). As such, ASV seems a safe mode of mechanical ventilation. However, their results also suggest that ASV may be unsafe in other scenarios. Indeed, although median-delivered V_T was similar with ASV compared with conventional mechanical ventilation with a fixed V_T of 6 ml/kg (6.27 *vs.* 6.08 ml/kg in the 60-kg group and 5.24 *vs.* 6.13 ml/kg in the 80-kg group), in certain scenarios, maximum-delivered V_T could be as high as 9.0 and 8.3 ml/kg in the 60-kg group and the 80-kg group, respectively. Such large V_T can and should never be seen as safe.

The commonly held view that large V_T ventilation may be tolerated as long as the PP remains at less than 30–35 cm H₂O has been questioned in a secondary analysis of the landmark study on lung-protective lower V_T ventilation by the ARDS Network.² To assess for independent effects of V_T reduction on mortality, Hager *et al.*³ constructed a multivariable logistic regression model. For this, the study groups were stratified by quartiles of PP. Hager *et al.* identified groups of patients who would have had similar PP had they been randomized to the same V_T strategy. The lower V_T strategy was associated with a lower mortality than the traditional V_T strategy in all PP quartiles. From this, we conclude that the beneficial effect of V_T reduction from 12 to 6 ml/kg is independent of PP.

The same may apply for patients at risk for ARDS. Gajic *et al.*⁴ reported significant variability in the initial V_T settings in mechanically ventilated patients without acute lung injury or ARDS at the onset of mechanical ventilation. Of the patients ventilated for more than 5 days, 25% developed lung injury within 5 days of mechanical ventilation. In this study, the main risk factors associated with the development of lung injury were the use of large V_T , next to transfusion of blood products, acidemia, and a history of restrictive lung disease. The odds ratio of developing lung injury was 1.3 for each milliliter of V_T above 6 ml/kg.

In this context, we would like to stress that the terminology chosen for lung-protective mechanical ventilation (using lower V_T) is wrong and maybe even misleading. Instead of “lower” V_T , we should use the term “normal” or “normally sized” V_T . Let us compare “traffic speeding” with lung-injurious forms of mechanical ventilation: traffic speeding (using too high V_T) during “rush hours” (ARDS) is dangerous, but traffic speeding (using too high V_T) may always be dangerous, even when there are not so many other cars on the road (no ARDS); therefore, regulations (guidelines) mandate that we should drive not faster than the speed limit (6 ml/kg). “Sacrificing” lower V_T with mechanical ventilation may be dangerous.

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References

1. Sulemanji D, Marchese A, Garbarini P, Wysocki M, Kacmarek RM: Adaptive support ventilation: An appropriate mechanical ventilation strategy for acute respiratory distress syndrome? *ANESTHESIOLOGY* 2009; 111:863–70
2. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. The Acute Respiratory Distress Syndrome Network. *N Engl J Med* 2000; 342:1301–8
3. Hager DN, Fessler HE, Kaczka DW, Shanholtz CB, Fuld MK, Simon BA, Brower RG: Tidal volume delivery during high-frequency oscillatory ventilation in adults with acute respiratory distress syndrome. *Crit Care Med* 2007; 35:1522–9
4. Gajic O, Dara SI, Mendez JL, Adesanya AO, Festic E, Caples SM, Rana R, St Sauver JL, Lymp JF, Afessa B, Hubmayr RD: Ventilator-associated lung injury in patients without acute lung injury at the onset of mechanical ventilation. *Crit Care Med* 2004; 32:1817–24

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In Reply:

We thank Drs. Dongelmans and Schultz for their letter expressing interest in our recent publication on adaptive support ventilation (ASV).¹ They correctly describe how ASV works but indicate that the ability of ASV to vary tidal volume in response to a changing clinical presentation is of concern especially if the tidal volume is allowed to exceed 6 ml/kg.

First, it is important to remember that the tidal volumes used by the Acute Respiratory Distress Syndrome Network² in its landmark study varied between 4 and 8 ml/kg. Indeed, as we showed in our study, even though the average tidal volume delivered to patients in the low-tidal volume arm was about 6 ml/kg, tidal volume did vary between 4 and 8 ml/kg in many patients.

We believe that allowing tidal volume to increase while keeping plateau pressure at a minimum setting (<28 cm H₂O in our study) is the major concern of Drs. Dongelmans and Schultz, and they reference Hager *et al.*³ to demonstrate their point. However, they failed to acknowledge the subse-

quent letter from Shiu and Rozen⁴ who determined from Hager's data that no significant change in mortality was observed regardless of tidal volume once plateau pressure was less than 28 cm H₂O. Drs. Dongelmans and Schultz also referred to the article by Gajic *et al.*,⁵ which was a retrospective review with plateau pressures available on only a few patients to illustrate the potential of large tidal volumes causing acute lung injury. The tidal volume range applied by ASV is essentially within the range of the lowest risk group (≤ 9 ml/kg) in the article by Gajic *et al.*⁵ In addition, there are numerous articles in the surgical literature that indicate that at least short-term application of large tidal volume does not result in lung injury⁶⁻¹⁰ in patients without existing lung injury. As we noted in our discussion, the upper and lower limits on ASV may need to be adjusted, and we believe that the upper limit should be set for patients with acute lung injury or acute respiratory distress syndrome at 8 ml/kg. However, the concept of ASV is sound because if practitioners are left on their own to adjust tidal volume, even centers who participated in the Acute Respiratory Distress Syndrome Network trial do not always appropriately select low tidal volumes and plateau pressures.¹¹

Where we believe the concept of ASV is most critical is in the patient where in spite of tidal volume being set at 6 ml/kg, plateau pressure exceeds 28 cm H₂O. It is very clear that in these patients, the risk of increased mortality is real.^{3,12} ASV does in these patients what the clinician should do and that is to reduce the tidal volume to avoid overdistension. ASV may not have the absolute limits correct, but the concept of closed loop control of ventilation is the future!

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References

1. Sulemanji D, Marchese A, Garbarini P, Wysocki M, Kacmarek RM: Adaptive support ventilation: An appropriate mechanical ventilation strategy for acute respiratory distress syndrome? *ANESTHESIOLOGY* 2009; 111:863-70
2. The Acute Respiratory Distress Syndrome Network: Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. *N Eng J Med* 2000; 342:1301-8
3. Hager DN, Fessler HE, Kaczka DW, Shanholtz CB, Fuld MK, Simon BA, Brower RG: Tidal volume delivery during high-frequency oscillatory ventilation in adults with acute respiratory distress syndrome. *Crit Care Med* 2007; 35:1522-9
4. Shiu KK, Rozen MJ: Is there a safe plateau pressure threshold for patients with acute lung injury and the acute respiratory distress syndrome? (letter) *Am J Respir Crit Care Med* 2006; 173:686
5. Gajic O, Dara SI, Mendez JL, Adesanya AO, Festic E, Caples SM, Rana R, St Sauver JL, Lymp JF, Afessa B, Hubmayr RD: Ventilator-associated lung injury in patients without acute lung injury at the onset of mechanical ventilation. *Crit Care Med* 2004; 32:1817-24
6. Wrigge H, Uhlig U, Baumgarten G, Menzenbach J, Zinserling J, Ernst M, Drömann D, Welz A, Uhlig S, Putensen C: Mechanical ventilation strategies and inflammatory responses to cardiac surgery: A prospective randomized clinical trial. *Intensive Care Med* 2005; 31:1379-87
7. Wrigge H, Uhlig U, Zinserling J, Behrends-Callsen E, Ottersbach G, Fischer M, Uhlig S, Putensen C: The effects of different ventilatory settings on pulmonary and systemic inflammatory responses during major surgery. *Anesth Analg* 2004; 98:775-81
8. Koner O, Celebi S, Balci H, Cetin G, Karaoglu K, Cakar N: Effects of protective and conventional mechanical ventilation on pulmonary function and systemic cytokine release after cardiopulmonary bypass. *Intensive Care Med* 2004; 30:620-6
9. Wrigge H, Zinserling J, Stüber F, von Spiegel T, Hering R, Wetegrove S, Hoeft A, Putensen C: Effects of mechanical ventilation on release of cytokines into systemic circulation in patients with normal pulmonary function. *ANESTHESIOLOGY* 2000; 93:1413-7
10. Lee PC, Helmsmoortel CM, Cohn SM, Fink MP: Are low tidal volumes safe? *Chest* 1990; 97:430-4
11. Kahn JM, Rubenfeld GD: Translating evidence into practice in the intensive care unit: The need for a systems based approach. *J Crit Care* 2005; 20:204-6
12. Petrucci N, Iacovelli W: Ventilation with lower tidal volumes *versus* traditional tidal volumes in adults for acute lung injury and acute respiratory distress syndrome. *Cochrane Database Syst Rev* 2003; 3:CD003844

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Low-lying Fruit or the Wrong Tree?

To the Editor:

I was intrigued by the use of the metaphor "Anesthesia's Low-Lying Fruit" by Orkin and Duncan¹ in their Editorial View entitled "Substrate for Healthcare Reform: Anesthesia's Low-Lying Fruit." I believe that it refers to the absence of data showing a major benefit conferred by anesthesiologists providing sedation for colonoscopy compared with other personnel using older drugs. The study for which the editorial was written, Alharbi *et al.*,² did not attempt to look for any benefits (or harms) from anesthesiologist involvement in colonoscopy. That study looked strictly at the demographics of the providers of sedation for outpatient colonoscopy. The absence of documented benefits presumably provides the low-lying fruit for healthcare benefit czars to pluck. Orkin and Duncan state that "Anesthesiologist involvement in colonoscopy sedation in the absence of medical indication . . . may be one vignette among myriad throughout United States health care in which low-benefit services and procedures result in disproportionate expenditures."

One place to start looking for benefits (or harms), rather than making assumptions from untested hypotheses, might be to ask the patients. Could a randomized controlled trial that compared midazolam and narcotic administered by registered nurses to the addition of propofol to that drug regimen by an anesthesiologist be performed? If such a trial included patient satisfaction as an outcome benefit, I will wager

The CNY Anesthesia Group, PC (Syracuse, New York), in which the author is a partner, receives remuneration for providing monitored anesthesia care for both colonoscopy and cataract surgery, as well as for all other forms of anesthesia for a myriad of operations.