New Investigations of Core Competencies

Perioperative Mechanical Ventilation and Assessment of Lung Function

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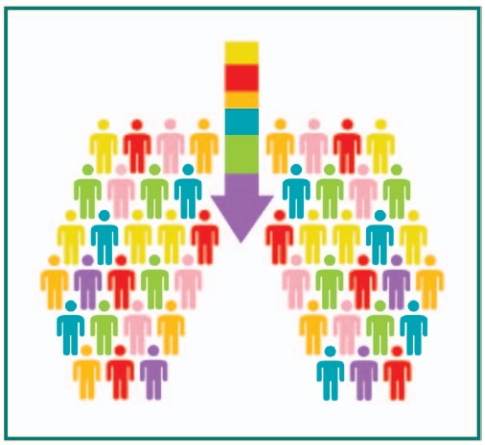
THE 2014 Journal Symposium focused on talks and investigations involving mechanical ventilation. The rationale for the symposium topic is that anesthetists likely ventilate more patients than any other care providers. In view of the millions of patients undergoing surgical procedures requiring general anesthesia with mechanical ventilation,* even small percent improvements in morbidity and mortality associated with mechanical ventilation would result in a substantial benefit.



"… the current issue of ANESTHESIOLOGY [brings] light to important aspects of [the] perioperative use [of mechanical ventilation]."

Concepts regarding mechanical ventilation have changed significantly with the realization that it is both beneficial and harmful. Just as there is an increasing understanding that we should personalize medication use in patients, the usage of mechanical ventilation will need to be adjusted to meet the needs of our individual patients. This editorial will review the publications associated with the symposium. In addition, this issue contains other articles on the topic of the symposium.

Modes of Mechanical Ventilation

Two publications in this month's journal discuss specific modes of mechanical ventilation that were compared for their effectiveness in our patients. In the study by Zhu *et al.*[1] on adaptive support ventilation, the investigators compared postoperatively physician-controlled ventilation using synchronized intermittent mandatory ventilation with pressure support to closed-loop adaptive support ventilation in patients undergoing fast-track cardiac valvular surgery. Adaptive support ventilation significantly decreased weaning time in these patients by more than 2 h. This was a randomized unblinded trial of patients in a single hospital, and the sample size was modest. Nonetheless, the adaptive support ventilation, a "closed-loop mode, where the ventilator computer adjusts the inspiratory pressure to a tidal volume that minimizes the work of breathing and switches between control and support breaths based on the absence or presence of spontaneous breath efforts,"[1] was superior in getting patients' tracheas extubated faster, without increasing complications, including reintubations. Once again, physicians are documented to be less efficient than a protocol[2] and as noted by the authors, synchronized intermittent mandatory ventilation has never been documented to be a superior mode of ventilation. Of note, the study indicates the potential benefit of the automated weaning system in a surgical population, in contrast to previous findings of better performance of such systems in mixed or medical intensive care unit populations.[3] This expands the promise of such automated approaches to optimize postoperative mechanical ventilation in surgical patients once technological and ethical issues are matured.

The second mode of mechanical ventilation discussed in this month's journal is high-frequency oscillation ventilation. A new meta-analysis of randomized controlled trials is offered, given that there are now seven randomized controlled trials on this subject. Despite early studies and meta-analyses suggesting a mortality benefit associated with this mode of ventilation in patients with severe lung injury, the current meta-analysis cannot document any differences in

Image: A. Johnson.

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* Anonymous: *National Hospital Discharge Survey: 2010 table, Procedures by Selected Patient Characteristics*—Number and percentage with and without procedures. 2012. Available at: http://www.cdc.gov/nchs/data/nhds/4procedures/2010pro_numberpercentage.pdf. Accessed February 5, 2015.

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the in-hospital mortality or the 30-day mortality.[4] In fact, the use of high-frequency oscillation ventilation was found to increase the duration of mechanical ventilation.

The issues raised in the meta-analysis document the clinical questions that still need to be addressed. High-frequency oscillation ventilation is a rescue therapy, and the optimal time to initiate as well as the length of time to maintain such therapies is not clear. A recent meta-analysis of prone ventilation as a rescue therapy of adult respiratory distress syndrome documented that prolonged use was associated with a survival benefit.[5] There is much more research needed to guide us on how to best ventilate patients with refractory hypoxemia.[6]

As for how we should ventilate our patients in the operating room, there are also too many questions to conclude that mechanical ventilation settings established predominantly in intensive care units and currently addressed as "lung-protective ventilation" are required for all patients. Certainly, we should always protect the lungs. Considering the marked distinction in the pulmonary physiology of surgical and acute respiratory distress syndrome patients and the mechanisms of ventilator-induced lung injury, settings corresponding to effective lung protection in each patient group are expected to differ. An excellent review by Goldenberg *et al.*[7] was published recently in this journal. There is no question that if a patient has acute respiratory distress syndrome or other lung damage, settings associated with that "lung-protective" approach should be used. Yet, as documented by Goldenberg *et al.*,[7] if the patient has a low baseline risk, there may be more harm than benefit with the use of those "lung-protective" settings, whereas patients with high baseline risk will benefit. Large-scale studies are underway to document which patient population best benefits from lung-protective ventilation and which components of ventilation (tidal volume, recruitment, positive end-expiratory pressure, or airway and tranpulmonary pressures) are necessary for their protection.

Adjuncts of Mechanical Ventilation

Two other publications from the symposium deal with adjuncts we should consider. The first is ultrasound of the lung, to be used for evaluation for pneumothorax.[8] A new paradigm is to evaluate the blood vessels to be cannulated, survey the lung to insure there is no pneumothorax preprocedure, use the ultrasound for documentation of cannulation, and then reevaluate the lung sliding to insure no pneumothorax was created by the procedure. By using the ultrasound in this manner, the usage of chest radiographs should be decreased, and anesthesiologists are responsible for the preprocedure and postprocedure evaluation.

The final publication addresses the basic science of isoflurane effects on airway function. Mechanical ventilation during anesthesia will frequently involve the associated use of a volatile anesthetic. The use of knock-out mice allowed the scientists to assess the role of transient receptor potential cation channel, subfamily A, member 1 (TRPA1), a ligand-gated nonselective cation channel in the airspaces of anesthetized mice.[9] Activation of TRPA1 appeared to be involved in suppressing the respiratory rate in anesthetized wild-type mice, probably by increasing the expiratory time due to increased bronchoconstriction or increased lung stiffness. These effects did not occur with sevoflurane. The importance of this finding is to be aware that isoflurane may be problematic in asthmatic patients or patients with stiffer lungs (lung fibrosis). The more we learn about our drugs and equipment, the better we can personalize and improve patient care.

Mechanical ventilation is a life support technique of prime relevance to expert anesthesiological practice. The articles in the current issue of Anesthesiology bring light to important aspects of its perioperative use. Furthermore, they indicate that factors specific to anesthetic management will need to be investigated and taken into account for optimal perioperative respiratory care of our patients.

Competing Interests

The authors are not supported by, nor maintain any financial interest in, any commercial activity that may be associated with the topic of this article.

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