

New Ventilator Modes: The Shape of Things to Come?

The complexities of mechanical ventilators have been chronicled in these pages over the last few decades as investigators and manufacturers have searched for improved outcomes and competitive advantage. On several occasions I have had the privilege of writing about the current state of the art and the promise of closed-loop mechanical ventilation.¹⁻³ While new modes of mechanical ventilation have failed to impact outcomes, the innovation and invention continue.

The promises of closed-loop ventilation include improved safety, improved patient comfort, and rapid response to change in patient condition. Survival outcomes are elusive and expensive. Under the current regulatory framework, the funds necessary to undertake a study capable of determining the effects of a new mode on outcome are not available. Manufacturers need only to demonstrate engineering success in a lung model in order to obtain marketing approval through the Food and Drug Administration's 510(k) process; patient studies are not required.

This leaves the clinician in a bit of a quandary. That is, unlike drugs, which have to prove superiority or noninferiority prior to marketing, new ventilation modes are available to the masses prior to any breadth of knowledge regarding application and safety. In essence, each new use is like a clinical research project with an *n* of 1 and no protocol or informed consent. To complicate matters, much of the education regarding new modes originates with the manufacturer. I have great admiration and respect for many of our colleagues in industry, but we rely too much on their educational initiatives, which drive new technology based on improved sales, not improved outcomes.

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In this issue of *RESPIRATORY CARE*, Desmettre et al introduce a new closed-loop technique dubbed auto-regulated inspiratory support (ARIS).⁴ In a twist to traditional dual-control modes of ventilation, in which the level of pressure support varies with changes in patient effort and pulmonary impedance, ARIS also alters the shape of the airway pressure waveform. This is also different than the use of rise time or slope controls,

which alter the speed at which the peak pressure is achieved. The ARIS system controls flow (rise time) automatically, to decrease work of breathing, and then alters the pressure waveform by adjusting flow after the desired peak pressure is reached. In Desmettre's Figure 1 this is demonstrated nicely in the last breath (Fig 1d), which shows a lower peak pressure, longer inspiratory time, increased mean airway pressure, and decrease in peak airway pressure from the beginning to the end of inspiration. Their study demonstrates that the ARIS system effectively alters ventilator output to meet an increased demand or an increased impedance.

The ARIS system is capable of 2 adjustments, compared to 1 adjustment with dual-control modes such as pressure-regulated volume control. The sophistication of microprocessors allows the breath to be shaped and tailored according to any number of goals. Rise time changes the slope of a pressure-support breath, whereas setting the flow-termination criteria changes the duration of a pressure-support breath. Both these maneuvers can result in improved patient comfort. ARIS, then, is a pressure-support method that can combine these adjustments in a single automated system.

The work of Desmettre et al in this group of animal experiments is well designed and executed. Their work contributes to our understanding of closed-loop control while exposing its critical weakness. The ARIS mode allows for reduced work of breathing and higher tidal volumes, along with lower P_{aCO_2} , but those may not always be our goals. If nothing else, the ARDS [Acute Respiratory Distress syndrome] Network studies have shown us that normalizing blood gases, while laudable and quantifiable, does not equate to improved outcome.⁵

As we evaluate new research and new technology, we must ask, how will this technique aid me in implementing a lung-protective approach? The respiratory system is an amazing, complex machine that makes a microprocessor-controlled ventilator appear like a Model T. Closed-loop control must use a multitude of inputs and outputs as well as allow us to tailor goals of mechanical ventilation aside from normalizing physiologic variables.

Closed-loop ventilation is in fact the shape of things to come. As our staff shortages continue and patients' severity of illness rises, we will rely on technology to bridge the

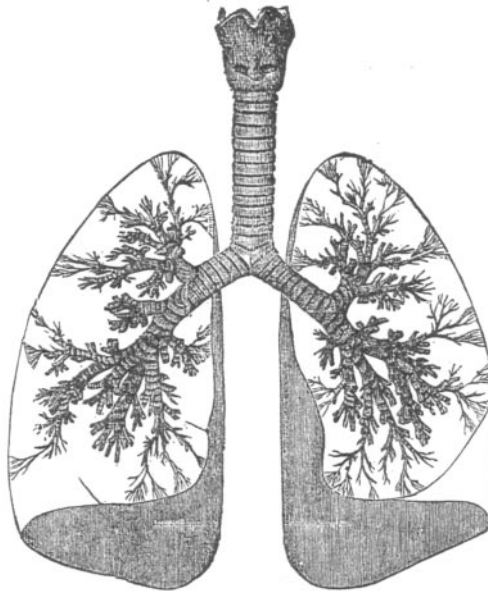
gap. As clinicians we must be permitted to shape the goals of closed-loop control to include lung protection.

Richard D Branson MSc RRT FAARC
Department of Surgery
Division of Trauma/Critical Care
University of Cincinnati
Cincinnati, Ohio

Richard D Branson MSc RRT FAARC, University of Cincinnati, Department of Surgery, 231 Albert Sabin Way, Cincinnati OH 45267-0558.
E-mail: richard.branson@uc.edu.

REFERENCES

1. Branson RD, MacIntyre NR. Dual-control modes of mechanical ventilation. *Respir Care* 1996;41(4):294–302.
2. Branson RD, Campbell RS, Davis K, Johannigman JA. Closed-loop mechanical ventilation. *Respir Care* 2002;47(4):427–453.
3. Branson RD, Johannigman JA. What is the evidence base for the newer ventilation modes? *Respir Care* 2004;49(7):742–760.
4. Desmettre TJ, Chambrin MC, Mangalaboyi J, Pigot A, Chopin C. Evaluation of auto-regulated inspiratory support during rebreathing and acute lung injury in pigs. *Respir Care* 2005;50(8):1050–1061.
5. 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(18):1301–1308.



The larynx, trachea, right and left bronchus, and lungs.
From: *A Complete Handbook for the Hospital Corps of the US Army and Navy and State Military Forces*. Charles Field Mason, Major and Surgeon, US Army
New York: W. Wood and Company; 1906
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