Too Many Ventilator Modes!

Clinicians responsible for ventilator care are often perplexed by the number of modes available on modern critical care ventilators. Modes that seem identical perform differently, different modes perform identically, and seemingly identical modes can differ under certain conditions.[1] Even the term "assisting" can refer to the patient triggering the ventilator or the ventilator assisting the patient.[2] As confusion about modes could lead to clinical errors, how did this problem develop?

Modern intensive care unit (ICU) ventilators (8 models by my count) are complex high-technology machines manufactured in a competitive environment. As such, a machine is designed to be better and different than its competitors. Ventilator development requires 2 types of engineers: hardware engineers (putting transducers and solenoids into a box), and software engineers (geeks writing code). Basically, these machines are an integrated system of sensors, graphic displays, and solenoids (with feedback between them) that are, ultimately, controlled by a clinician. As an engineer-friend explained, a ventilator is similar to an aircraft, and controlling an aircraft requires a knowledgeable pilot (or clinician).

Over the years, each ventilator has been improved by adding enhanced hardware and refining the pneumatic/electronic circuitry. The point is, hardware differs between machines. Software engineers write complex code that controls solenoid performance based on sensor and clinician inputs. Software algorithms differ markedly between machines. As well, companies retain clinical experts to recommend mode improvements. Incorporating new modes requires FDA approval, which becomes an expensive, lengthy process. Protecting the investment includes patent submissions and copyrights of the product name, its features, and, quite often, the modes. Therefore, modes are truly different between ventilators, and their names are often proprietary. But modes may not be clinically different.

Understanding that performance differs between ventilators, test lung studies have been conducted to compare and contrast modes. Marchese et al recently evaluated mode differences between 6 ICU ventilators, concluding that the ventilators performed acceptably, but some performed inadequately with specific settings.[3] In an evaluation of 7 home care ventilators, Blakeman et al found wide variability in battery duration and triggering sensitivity between machines.[4] High respiratory rate and low tidal volume conditions presented problems for 2 of the ventilators. Evaluating whether technical differences between machines are of clinical importance is a responsibility of the clinician. The difficult-to-ventilate patient might benefit from a specific mode under a particular condition compared to, for example, the option of administering sedation.[5,6]

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Therefore, sorting out the confusion between ventilator modes is a challenge. In this issue of Respiratory Care, a survey of ventilator experts seeks to establish a basis for agreement on ventilator mode nomenclature.[2] After an aggressive recruitment effort to query qualified experts, response to the survey was a disappointing 15%. However, since the responses did not differ greatly between disciplines, the results can probably be generalized. The survey revealed a broad agreement with the proposed constructs (mode characteristics). The authors concluded that the survey supports establishment of standardized nomenclature.[2] The construct questions considered basic mode characteristics in common with all ventilators, but did not include questions regarding more advanced modes or features. Newer single-machine ventilator modes are being driven by feedback loops guided by measures of volume/rate, end-tidal partial pressure of carbon dioxide (P_{ETCO_2}), impedance, and esophageal pressure. These feedback signals are inherent to the specialized modes adaptive support ventilation (ASV), SmartCare, proportional assist ventilation (PAV), and neurally adjusted ventilatory assist (NAVA). Considering the 15% response rate, additional questions about advanced modes would have, quite likely, further reduced the low response rate.

Therefore, the task of finding agreement about nomenclature is daunting, considering the new modes being developed by industry. Quality control efforts within an institution are frequently in support of this cause. A common recommendation, unwise in my opinion, is to restrict mechanical ventilation within an institution to one ventilator model. The argument is usually based on the contention that clinicians in training will make fewer errors if only one ventilator with one set of modes is available. However, this argument denies the ability to prescribe care delivered by other, possibly better modes or machines. Are clinicians in training incapable of learning differences between modes!? This position is unfortunate because, sim-

ply, no one ventilator provides all potential options for improving care, particularly when treating the 2 major ventilator-patient challenges: efficient/effective weaning and treating ARDS.

Chatburn et al should be further encouraged to create a consensus regarding nomenclature. However, unless a clear safety concern is apparent (as monitored loosely by the FDA approval process), broad adoption of a nomenclature system is unlikely. More likely, innovations that generate new modes will outpace the efforts to standardize and regulate nomenclature, especially as feedback control becomes more common. At this time, the solution is education. The details of mode function must be thoroughly in-serviced by clinical educators and industry. Responsible ICU practitioners should know all modes and machines in their institution. They should be prepared to change modes or machines to improve care as necessary, and respiratory therapists are uniquely trained to accept this responsibility.

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