variable. To further complicate matters in severe asthma, airway closure may occur at relatively high lung volumes, and the routine techniques for measuring auto-PEEP or the degree of hyperinflation as assessed by the volume exhaled during apnea may underestimate the true degree of hyperinflation.\(^1\)

Third, the Consensus document suggests that one of the most effective ways of decreasing auto-PEEP is by decreasing minute ventilation. It is not clear that at any given minute ventilation that a decrease in VT is indeed the optimum strategy to apply to minimize hyperinflation. For example, if one assumes a given inspiratory flow rate, and hence a given inspiratory time, as well as assuming that exhalation occurs as a simple exponential, then hyperinflation would be minimized by using a larger tidal volume rather than a smaller tidal volume (at a given minute ventilation). This may not seem intuitively obvious given the scenario outlined in Dr. Manning’s letter, but it occurs because the initial emptying of the lung occurs much quicker from a higher lung volume and the time for emptying is longer since the respiratory rate is lower. What happens to patients with severe airways obstruction, who clearly have very inhomogeneous lungs, is not entirely certain.

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Terminology vs Physiology and Mechanics

To the Editor:

I enjoyed the excellent review of “Pressure-preset Ventilation” by Dr. Blanch et al.\(^1\) Since they raised the issue of terminology, I would argue, however, that they have contributed to the confusion. The problems related to nomenclature in the area of mechanical ventilation have been reviewed extensively elsewhere,\(^2,3\) and a consensus has been reached among representatives of the pulmonary medicine community.\(^4,5\) Specifically, the term “pressure controlled,” as opposed to “pressure preset” or other terms, has been suggested as most consistent and logical for a variety of reasons. First and foremost, it is based on a widely used mathematical model of the interaction of the ventilator and respiratory system. This model is the equation of motion for the respiratory system:

\[
\text{Pressure} = \frac{\text{Volume}}{\text{Compliance}} + \text{Resistance} \times \text{Flow},
\]

which says that at any time only one of three variables, ie pressure, volume, or flow, may be the independent variable while the others are dependent variables. The authors are surely aware of the equation of motion for all of the equations in their paper are derived from it. The equation expresses mathematically that the ventilator must manipulate or “control” the behavior of one of these variables. That is, it must shape the pressure, volume, or flow waveforms. This control extends over the entire inspiratory time. The term “preset” is less informative, because it implies that the ventilator attempts only to achieve a particular value at one point in time, as in a preset tidal volume. Also, the term “control” is used by some manufacturers already while the term “preset” is not.

Marini has popularized the term “pressure-targeted,”\(^6\) but this refers to a physiologic approach to limiting lung damage and is independent of how the ventilator delivers a breath.

Inasmuch as volume and flow are inverse functions, we can simply say that inspiration is either pressure controlled or volume controlled. The authors object to the word “controlled” as it may refer a particular type of ventilator, in this case the Siemens Servo. That is like objecting to the word “avenue” just because there is a particular “Madison Avenue.” Yet while they object to the term “pressure controlled,” they seem to have no problem with the term “volume controlled,” a potentially confusing contradiction.

The authors’ use of the word “controlled” is inconsistent, they also use it in reference to types of breaths rather than modes of ventilation. They imply that “controlled” or “assisted” breaths are somehow “mechanical,” which is in some way different from “spontaneous.” None of these terms are explicitly defined, and the reader unfamiliar with the intricacies and jargon of ventilator operation, evidently the intended audience of the paper, will be lost. This is typical of what you find in much respiratory literature and is the reason why there is confusion.

My guess is that the authors use “controlled” to mean a breath that is initiated by the ventilator, while “assisted” means a breath that is initiated by the patient. These concepts were created by anesthesiologists in the 1950s\(^5\) and are promulgated on some, but not all current ventilator mode selection labels, eg, Infrasonics Adult Star and Newport Wave. The original use of the words “control” and “assist” was to distinguish between situations where the patient was paralyzed, eg, polio or curare, or not. This distinction pales into insignificance, given the complexity of modern ventilators and clinical situations. Trying to apply these old concepts to modern technology is like using White Out on a computer screen. We need to examine carefully the distinctions of importance and then use terminology that adequately describes them.

All of the confusion surrounding ventilation terminology can easily be avoided. First, we must abandon our ingrained, contradictory paradigms. We must recognize that from an engineering and physiologic standpoint that the ventilator is designed to manipulate either pressure or volume delivery to the patient. If pressure remains consistent as the load imposed by the patient changes, then inspiration is pressure controlled. Conversely, if volume remains consistent as the load changes then inspiration is volume controlled. Indeed, some ventilator manufacturers have adopted this convention, eg, Siemens and Puritan Bennett. If a patient initiates a breath, it is patient triggered, not assisted. If the ventilator initiates a breath it is machine triggered, not controlled. If the patient both initiates and terminates a breath, it is a spontaneous breath because the patient can determine the rate and size of breaths. If the ventilator initiates a breath, terminates a breath, or both, then it is a mandatory breath because the patient cannot control the rate or size of breaths. If airway pressure rises above baseline during inspiration, that is, if the ventilator does work on the patient, then the breath is assisted, regardless of any other characteristics of the breath. Most certainly, the patient does not assist the ventilator, as I have heard some clinicians say.

The complete spectrum of full ventilatory support through partial ventilatory support to no ventilatory support is easily described as follows: continuous mandatory ventilation (CMV); intermittent mandatory ventilation (IMV), synchronized or not; and continuous spontaneous ventilation (CSV), to avoid the confusion of CPAP vs PEEP.\(^6\) CMV and IMV may be either volume or pressure controlled while CSV can only be pressure controlled. Using these simple, logical definitions, all confusion and inconsistency vanish.

I believe the concepts discussed above are important in communicating information among experienced clinicians. They are especially important, and considerably easier to accept, among
neophytes. There are, however, some minor additional items for consideration. First is the use of the terms "accelerating" and "decelerating" to refer to inspiratory flow waveforms. These terms have been introduced and propagated by ventilator manufacturers with little regard for linguistic accuracy. The terms "ascending ramp" and "descending ramp" are more appropriate than "accelerating" and "decelerating flow." The term "ramp" is borrowed from electronic engineering and is preferred for three reasons. First, the name "ramp" gives a more obvious visual image of actual shape of the waveform. Second, "ramp" has been described mathematically and used universally in other disciplines for much longer than mechanical ventilators have been in existence. Third, the analogy of something accelerating or decelerating is misapplied. For example, when a car is moving we say it has a certain speed, i.e., speed = Δdistance/Δtime. If the speed increases with time, then we say that the car accelerates, i.e., acceleration = Δspeed/Δtime, not that the speed accelerates. The speed of moving gas is expressed as a flow rate, i.e., flow rate = area of tube X Δdistance/Δtime. If the flow rate increases, we would properly say that the gas accelerates, i.e., acceleration = Δflow rate/Δtime, not the flow accelerates. In scientific terms, "The acceleration of a particle is the rate of change of its velocity with time."  

Finally, the use of the symbol Paw for "mean airway pressure" seems inappropriate. The mathematical convention of using a bar above a letter signifies the mean of the variable the letter represents. A bar above "aw" thus symbolizes "mean airway," but there is no such thing as a "mean airway." What we want to express is mean pressure in the airways. Thus, the symbol should be Paw. This convention has been adopted by the medical journal Respiratory Care. In conclusion, I hope the authors do not interpret my comments as a personal attack. They are meant only to stimulate open, rational discussion about a topic that affects everyone writing and reading about the subject of mechanical ventilation.

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To the Editor:

We thank you for the opportunity to respond to Mr. Chatburn's comments. In his enthusiasm for his newly proposed ventilator classification scheme (Respir Care 1991;36: 1123-55 and Respir Care 1992; 37:1000-25) and redefined nomenclature for breath types (Respir Care 1993; 207-09), he may have overlooked several important issues. First, we did not "raise the issue of terminology" as he says. Rather, because of confusion, some of which results from terminology, our intent in writing the article was to clarify the physiologic and mechanical principles specifically involved with pressure-preset ventilation (Chest 1993; 104:590-99 and Chest 1993; 104:904-12). In Part 1 (Chest 1993; 104:590-99), we differentiated what terms we preferred to use for our discussion—terms that are commonly used and well-known. We think this was an especially appropriate strategy because of the nature of our article—it is a review article. By definition, a review article is an analysis of previously published scientific works on a particular subject. Incorporating novel classification schemes or new nomenclature into such a discussion, even if it were logical or clear, could create further confusion. With this in mind, we feel Mr. Chatburn's assertion, that we "have contributed to the confusion," is, at best, overstated and perhaps self-serving. On a more practical note, early drafts of our manuscript have been completed and were undergoing editorial revision by the time Mr. Chatburn began to promote his recommendations. Therefore, none of the authors had knowledge of them. Further, none of the five impartial experts in the field of pulmonary physiology and mechanical ventilation who reviewed our manuscript, two from other departments at the University of Florida and three selected by Chest editors, suggested that we read the articles he cites or expressed concerns about our terminology.

While it is extremely unlikely that our use of the term "exponentially decelerating flow waveform" confused anyone, we do agree with Mr. Chatburn that flow does not decelerate per se. The term "descending ramp," however, is equally, if not more, misleading—except when describing volume-controlled ventilation. A ramp waveform describes a linear decrease in flow over time, that is, a first order function. This is precisely the type of pattern a volume-control ventilator produces when it is set to decrease flow throughout inspiration. The term "ramp," however, fails to describe accurately the flow profile produced in pressure preset ventilation. The exponentially diminishing flow pattern in this type of ventilation is often curvilinear, a higher order function—in fact, it is both visually (Fig 1) and physiologically

![Figure 1](http://journal.publications.chestnet.org/pdfsaccess.ashx?url=/data/journals/chest/21703/)