

results in different PEEP levels occurring in various lung units based on the lung mechanics of the unit. Lung units with long time constants (high airway resistance and/or high compliance) always develop the greatest auto-PEEP, whereas lung units with the shortest time constants (low compliance and/or low resistance) always develop the least auto-PEEP. As shown in the mathematical discussion by Chatburn and Kallet, lung units that are really stiff, as in severe ARDS, may have such short time constants that they fully collapse, even with a very short low CPAP time. This, as discussed, results in a repetitive opening and closing of lung units, causing atelectrauma.

Attempting to base the needed PEEP level on the use of auto-PEEP is always physiologically unsound and always has the potential of causing more lung injury. In our opinion, one should never establish PEEP by the use of auto-PEEP, because the risks *always* outnumber the potential benefits.

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Dr Mirelea-Cabodevila has a patent on mid-frequency ventilation with no monetary gain. Dr Kacmarek has disclosed relationships with Covidien, Orange Med, and Venner Medical.

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**Intermittent Mandatory  
Ventilation Will Live Forever**

*To the Editor:*

Reading the article by Kacmarek and Branson<sup>1</sup> about whether intermit-

tent mandatory ventilation (IMV) should be abolished, it seemed like arguing whether flip phones should be abolished (eg, in favor of smart phones). Yes, flip phones are still used, but they represent a technological anachronism, and any discussion about their role in everyday communications has become essentially irrelevant. But whether the discussion about IMV is irrelevant depends on how it is defined.

In the introduction of the paper,<sup>1</sup> IMV was defined as “a mode of ventilation where intermittent mandatory breaths are delivered at clinician-defined intervals, and between these mandatory breaths, the patient can breathe spontaneously or with pressure-supported breaths.” In the first place, thinking of IMV as a “mode” (vs the breath sequence component of a complete mode classification<sup>2</sup>) is a very restricted use of the term. It indicates an outdated paradigm that limits understanding of currently available options for ventilation and prevents a clear vision of future developments.

More importantly, the authors never give definitions for “mandatory” or “spontaneous” breaths, upon which the definition of IMV depends. The result is a certain level of ambiguity that might prevent the reader from appreciating the full scope of the subject. A spontaneous breath is one for which inspiration is both triggered and cycled by the patient (ie, the patient’s brain); a mandatory breath is one for which inspiration is either triggered or cycled by the ventilator.<sup>2</sup> Note that the definition of a spontaneous breath does not imply any particular level of assistance for the work of breathing and, indeed, does not even imply connection to a ventilator. Non-intubated people breathe spontaneously, and intubated patients on CPAP breathe spontaneously, as do those on some type of assistance (eg, pressure support, proportionally assisted ventilation plus, neurally adjusted ventilatory assist, automatic tube compensation).

Herein lies the problem. The authors completely ignore the fact that there are actually 3 different varieties of IMV. In type 1, preset mandatory breath frequency is always delivered; in type 2, mandatory breaths are delivered only when the spontaneous breath frequency is less than the preset mandatory breath frequency; and in type 3, mandatory breaths are delivered only when the spontaneous minute ventilation (ie, spontaneous breath frequency times average spontaneous breath tidal volume) is less than the preset minute ventilation.<sup>2</sup>

Type 1 IMV was the original, as described by Kacmarek and Branson.<sup>1</sup> Type 2 IMV exists today as, for example, on the Philips Respironics V60 ventilator in the mode called “spontaneous/timed.”<sup>3</sup> Type 3 IMV was originally invented way back in 1977 by Hewlett et al<sup>4</sup> and called “mandatory minute ventilation.” That mode is still available today on Dräger ventilators (called “mandatory minute volume ventilation”) and on Maquet ventilators (called “AutoMode”<sup>5</sup>) and has evolved further into the mode called “adaptive support ventilation” on Hamilton ventilators.<sup>6</sup>

The important point is that type 2 and 3 IMV both *allow spontaneous breaths to suppress mandatory breaths*. That feature casts a whole new light on IMV. To put this into a clinical context, it is helpful to categorize patients into 4 basic groups: (1) those incapable of generating spontaneous breaths (eg, organ donors and patients under neuromuscular blockade); (2) those with unreliable spontaneous breath rates (eg, premature infants); (3) those with little risk of apnea (perhaps the majority of ventilated patients); and (4) those with no need of mandatory breaths at all (eg, patients undergoing spontaneous breathing trials). Of course, this spectrum of breathing ability can and often does occur in a single patient, so perhaps it is better to think of the 4 groups as levels of mandatory breath requirement (ie, complete dependence, intermittent depen-

dence, and complete independence). Hence, there is a need for the ventilator, in general, to provide for both spontaneous and mandatory breaths on an intermittent basis. This was the motivation for inventing IMV in the first place, as Kacmarek and Branson mentioned in their paper.<sup>1</sup>

How does recognition of only type 1 IMV (as in the article by Kacmarek and Branson<sup>1</sup>) impair our understanding of modes? There are only 3 basic goals of mechanical ventilation (safety, comfort, and liberation),<sup>7,8</sup> and the unique benefit of IMV is that can serve all three. All forms of IMV allow presetting of a minimum minute ventilation, serving the goal of *safety*. Allowing spontaneous breaths to suppress mandatory breaths serves the goal of *comfort* because spontaneous breaths are invariably more synchronous with patient breathing efforts than mandatory breaths (ie, allowing the patient to control the timing of breaths is better than imposing arbitrary values for frequency and inspiratory time). Finally, elimination of mandatory breaths (through automatic suppression) and automatic reduction in ventilatory support is a safe and effective approach to serving the goal of *liberation*.<sup>9,10</sup> But if we only perceive the existence of type 1 IMV and its service of the goal of safety, then we fail to recognize how IMV can effectively serve the all 3 goals of ventilation.

Furthermore, perceiving only type 1 IMV, we fail to observe that type 3 IMV is the new paradigm for advanced modes of ventilation (with adaptive, optimal, or intelligent targeting schemes<sup>8</sup>) that will likely become more common in the future<sup>11</sup>. Over the last 30 years or so, we have seen modes of ventilation evolve from simple volume assist/control, serving only the goal of safety,<sup>7</sup> to complex modes like Intellivent-ASV<sup>12</sup> that use artificial intelligence tools to serve all 3 goals.<sup>7</sup> This makes sense in light of the levels of mandatory breath dependence as men-

tioned above. And if you accept that those levels may occur in any patient at any time, then it follows that the “ultimate mode” of ventilation (yet to be invented) would be able to provide all levels: full support with all mandatory breaths, partial support with IMV, or some level of assistance with all spontaneous breaths, switching between levels automatically according to patient need. It does not take much imagination to see that this ultimate mode of ventilation would be, by definition, some sort of IMV. What remains to be developed are the ultimate targeting schemes<sup>8</sup> for controlling and coordinating the mandatory and spontaneous breaths. Other modes will not be needed except (perhaps) in rare specialty applications. Hence, I assert that in the not too distant future, virtually all modes will be some form of IMV.

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**Intermittent Mandatory  
Ventilation: What's in a Name?**

*In Reply*

That which we call a rose, By any other name would smell as sweet.  
—William Shakespeare

Chatburn finds fault in our description of intermittent mandatory ventilation (IMV),<sup>1</sup> as we primarily discuss IMV as first described by Downs.<sup>2</sup> That is, a preset mandatory rate with spontaneous breaths allowed between mandatory breaths. And although we appreciate the work Chatburn has done<sup>3</sup> in further refining the work of Mushin et al<sup>4</sup> in classifying ventilators and ventilator operation, in his letter he also does not use his classification system when making reference to modes. He refers to IMV as IMV and pressure support and proportional assist ventilation and neurally adjusted ventilatory as-