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Less usual ventilatory modes II: BIPAP and Automode

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Abstract

Mechanical ventilation is a lifesaving intervention and represents one of the most important treatments ever introduced in intensive care units, but it can cause lung damage if not used properly, knowledge of each mode is prudent for safe utilization. Intermittent mandatory ventilation is a type of breath sequence in which you can see spontaneous and mandatory breaths coexisting in different manners. It can serve all three basic goals of mechanical ventilation: safety, comfort, and liberation. Taxonomic attribute grouping abbreviates the ventilation mode that has three components: control variable; ventilation sequence; and target control scheme. It clarifies the mode's operation and mechanics.
We'll review two less usual ventilatory modes with two different types of IMV breath sequence (type 1 and 2): BIPAP (Dräger) and Automode (Maquet-Getinge).

Keywords: mechanical ventilation, intermittent mandatory ventilation, taxonomic attribute grouping.

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Introduction

Mechanical ventilation is a life-saving modality in Intensive Care Units (ICU). It is used to mechanically assist spontaneous breathing or provide mandatory breaths if the patient is apneic. [1] It has evolved over the last several decades from simple high pressure gas regulators to sophisticated microprocessor systems controlling many aspects of breath delivery, inspiratory/expiratory timing, and expiratory pressure. [2]

A mechanical ventilation mode describes the predetermined pattern of patient-ventilator interaction. A logical nomenclature for these modes was proposed, akin to biological taxonomy. Accordingly, the control variable, breath sequence, and targeting schemes for the primary and secondary breaths represent the order, family, genus, and species, respectively, for the described mode. To distinguish unique operational algorithms, a fifth level of distinction, termed variety, is utilized. [3]

As we reviewed in our previous paper, [4] intermittent mandatory ventilation (IMV) is defined as the ability for spontaneous breaths to exist between mandatory breaths. [5] A spontaneous breath is one for which inspiration is both triggered and cycled by the patient (i.e., the patient's brain) and a mandatory breath is one for which inspiration is either triggered or cycled by the ventilator. [6]

According to Mireles-Cabodevila et al, [3] there are three basic goals of mechanical ventilation: safety, comfort, and liberation, [3] and the unique benefit of IMV is that it can serve all three goals. [7] Also, IMV is the basis of most of the modes available on advanced mechanical ventilators today. [8]

Despite a variety of modern ventilators, weaning patients from mechanical ventilation utilizes a significant amount of health care resources in an ICU. [9] Alternative modes of ventilation were developed to prevent lung injury and asynchrony, promote better oxygenation and faster weaning, and be easier to use. However, evidence of their benefit is scant. [10]

Methods

A short but comprehensive review of the literature was carried out, looking for terms as taxonomy mechanical ventilation, intermittent mandatory ventilation, biphasic positive airway pressure and automode. The authors selected those papers they thought were more relevant.

Objectives

- Review what IMV is, especially type 1 and 2.
- Know how BIPAP and Automode work.
- Describe the taxonomic attribute grouping of both modes.

Review

Most IMV modalities allow clinicians to preset a minimum level of minute ventilation, ensuring patient safety. Enabling spontaneous breaths to suppress mandatory breaths enhances comfort, as these breaths are naturally more synchronous with the patient's own respiratory efforts. The automatic suppression or elimination of mandatory breaths, together with a progressive reduction in ventilatory support, represents a safe and effective strategy for promoting weaning and eventual liberation from mechanical ventilation. [7]

IMV has evolved into 5 distinct varieties. [5,11] In this paper we will review two modes of mechanical ventilation that use type 1 and 2 IMV. In type 1, mandatory breaths are always delivered at set breath rate. On the other hand, type 2 allows spontaneous breaths to suppress mandatory breaths. [7]

Every ventilation mode has three components: the control variable; the ventilation sequence; and the target control scheme. These three variables are abbreviated and form a label or grouping by taxonomic attributes: taxonomic attribute grouping (TAG). [12] For IMV, at least 2 symbols are used in the targeting scheme, where the first refers to the mandatory breaths and the second to the spontaneous breaths. [6]

Biphasic Positive Airway Pressure (BIPAP)

In 1989, Baum et al described biphasic positive airway pressure ventilation. [13] BIPAP (Dräger, Germany) is a type of pressure-controlled ventilation that permits unrestricted spontaneous breathing at any time during the ventilatory cycle, [14] while the number of mandatory breaths is pre-set. [15] This is an IMV type 1: IMV(1) where mandatory breaths are always delivered. [6,7] The goal is to allow unrestricted spontaneous breathing to reduce sedation and promote weaning. [10]

In this mode, the mandatory breaths exhibit both an inspiratory as well as expiratory synchronization with the patient's breathing efforts. Machine-triggered mechanical breaths are applied if no spontaneous breathing is detected

during the inspiration trigger window. [15] The ventilatory frequency is the minimum and at the same time the maximum number of mandatory ventilations that the patient receives. [16]

A synchronization window is a short period at the end of a preset expiratory time during which a patient signal may be used to synchronize the trigger event with a patient inspiratory effort signal. Therefore, if a patient inspiration effort signal appears in the synchronization window, and it is large enough to meet the trigger sensitivity criterion, then the inspiration is patient triggered. Generally, such an inspiration is machine cycled and hence results in a mandatory breath. Patient triggering in the synchronization window shortens the expiratory time, so the ventilator usually extends the expiratory time before the next breath to keep the set mandatory breath rate constant. The portion of expiratory time that is not in the synchronization window is called the trigger window. During the trigger window (minus a short refractory period to prevent inadvertent double triggering) a sufficiently large patient signal can start inspiration (i.e., patient-triggered, patient-cycled spontaneous breath). [5]

BIPAP also uses a synchronization window at the end of the inspiratory time of a pressure controlled, time cycled breath. If the patient signal occurs during such an inspiratory time synchronization window, expiration starts ending the mandatory breath. [17]

The distinction between a synchronization window and a trigger window is what makes the set mandatory breath rate the highest possible for IMV and the lowest possible for continuous mandatory ventilation (CMV). [5]

Synchronization of mechanical inflation with the patient's inspiratory effort is associated with lower airway pressures, improved hemodynamics, and reduced risk of ventilator-induced lung injury (VILI). [18]

Because unrestricted spontaneous breaths are permitted at any point of the cycle, the patient contributes to the total minute ventilation (usually 10%–40%). [10]

BIPAP delivers pressure-controlled (PC), time-triggered, and time-cycled breaths using a set point targeting scheme ("s"). This means that the ventilator maintains a constant pressure (set point) even in the face of spontaneous breaths. [10] Its TAG is PC-IMV(1)s,s. [3,5,6,19]

It has the same TAG as BiLevel (Medtronic, Puritan Bennett 980) and Airway pressure release ventilation (APRV). [19]

In ARDS patients, BIPAP can improve oxygenation, hemodynamics, lung mechanics, decrease sedation use, and decrease duration of mechanical ventilation. [14] By preserving spontaneous breathing, it will improve ventilation-perfusion matching and gas diffusion, improve the hemodynamic profile and improve synchrony. [10]

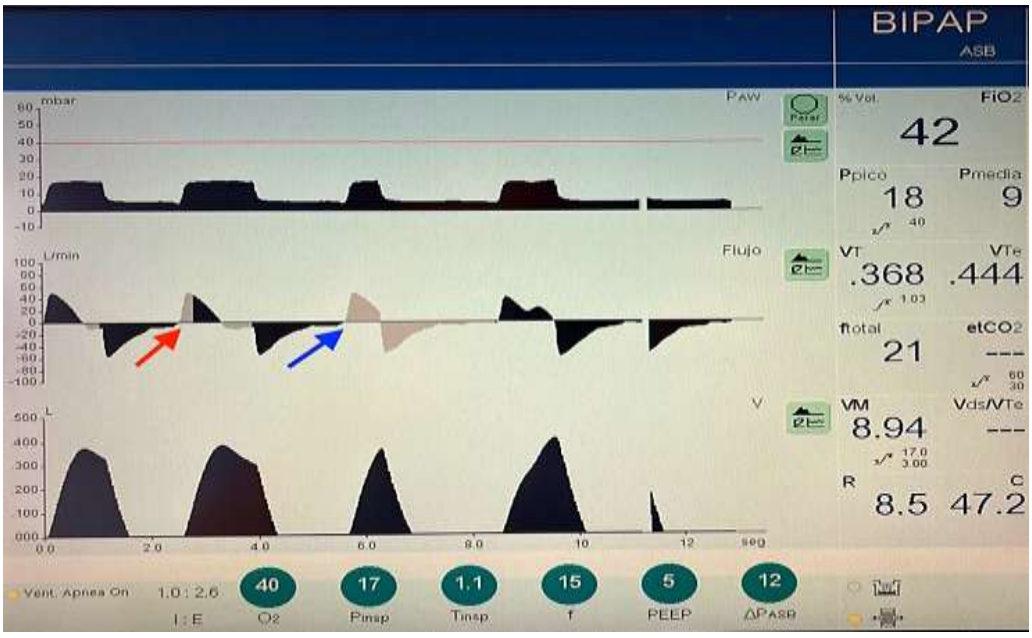

Figure 1: BIPAP mode in a Dräger Evita XL ventilator. Set parameters: inspiratory pressure (Pinsp), respiratory rate (f), inspiratory time (Tinsp), pressure support above PEEP, PEEP and FiO_2. Red arrow: inspiratory effort during synchronization window starts a mandatory breath (patient-triggered and machine-cycled). Blue arrow: inspiratory effort during trigger window starts a spontaneous breath (patient-triggered and patient-cycled

Automode

In Automode (Maquet-Getinge, Sweden) ventilator controls pressure during inspiration. Patient variables (resistance, compliance, and muscle effort) will determine the resulting flow and tidal volume. [20]

The Automode function enables the patient to initiate a ventilator mode change. [21] This is a type 2 IMV: IMV(2). That is, spontaneous ventilations suppress mandatory ventilations if they occur more frequently. [16]

The algorithm that governs the number of spontaneous breaths, required to suppress mandatory breaths, varies among mechanical ventilators. In this case, if the patient stops breathing, the mandatory rate is activated. The programmed rate is the minimum the patient will have, regardless of their own ventilatory rate. [16]

In some scenarios, such as those patients emerging from anesthesia, these ventilatory sequences are likely to be relevant, as they could potentially minimize patient-ventilator asynchrony. [22] One study showed that Automode weaning trended toward more rapid extubation than conventional protocol-driven ventilation in conjunction with a standardized weaning protocol in patients after coronary artery bypass graft. [21]

The ventilator system starts in pressure control (PC), pressure regulated volume control (PRVC) or volume control (VC) mode. If the patient triggers a breath, the ventilator system will turn to the relevant supported mode to encourage the patient's respiratory drive. The ventilator system initially adapts with an increasing apnea time. This means that for the spontaneously triggering patient, the apnea time increases successively until the level set in the settings window for the maximal apnea time parameter is reached after 10 consecutive spontaneously triggered breaths. Exceeding the maximal apnea time setting without a sufficient patient effort will cause in volume support (VS), a PRVC or VC breath will be delivered according to the selected Automode functionality and in pressure support (PS), a PC breath will be delivered. [20] The options to choose from in the Servo-U ventilator are:

PC to PS. Its TAG is PC-IMV(2)s,s [3,5,6,19]
PRVC to VS. Its TAG is PC-IMV(2)a,a [3,5,6,19]
VC to VS. Its TAG is VC-IMV(2)s,a [3,5,6,19]
In this combination, the ventilator system uses the plateau pressure in the VC breath as a reference pressure for the first VS breath. [20]

With an adaptive targeting scheme (“a”), the ventilator adapts a function to achieve a goal. In this case, the ventilator is programmed by the operator to achieve a tidal volume (the target), and the inspiratory pressure is automatically adjusted to achieve that target (on average, as resistance, compliance, and patient effort change) using a preprogrammed algorithm. [16]

Do not confuse Automode with Autoflow (Dräger, Germany) which refers to an adaptative scheme control (PC-CMVa) similar to PRVC. [19]

Figure 2: Automode (PC <-> PS) in a Servo-I ventilator. Parameters to set are pressure control above PEEP, respiratory rate (F resp.), PEEP, FiO_2, and pressure support above PEEP.

Table 1: Comparison between the two modes. Abbreviations not used previously: RR (respiratory rate), End insp (end inspiration criterion), I:E (inspiratory-expiratory ratio), Max apn T (maximum apnea time), Tpause (inspiratory pause time).

Mode	BIPAP	Automode		
		PC<->PS	PRVC<->VS	VC<->VS
Control variable	PC	PC	PC	VC
Breath sequence	IMV(1)	IMV(2)	IMV(2)	IMV(2)
Targeting schemes (mandatory breath, spontaneous breath)	s,s	s,s	a,a	s,a
TAG	PC-IMV(1)s,s	PC-IMV(2)s,s	PC-IMV(2)a,a	VC-IMV(2)s,a
Programed parameters	Pinsp, RR, Tinsp, PEEP, FiO_2, △Pasb, Trigger, End insp.	PC above PEEP, RR, I:E, PEEP, FiO_2, Trigger, PS above PEEP, End insp, Max apn T.	VT (target), RR, I:E, PEEP, FiO_2, Trigger, End insp, Max apn T.	VT (programed and target), Tpause, RR, I:E, PEEP, FiO_2, Max apn T.

Conclusion

It is important to know how different mechanical modes work for the management of critical care patients. In this sense the TAG helps us to interpret the ventilatory behavior of different modes, but we must also try to be familiar with the ventilatory modes we have.

These two less usual ventilatory modes use two types of IMV breaths with different targeting schemes that we must understand in order to apply them to our patients, especially if they start with spontaneous breaths.

IMV(2) are more likely to promote synchrony than modes with IMV(1) because mandatory breaths may be suppressed by spontaneous breaths and could make an effective approach to weaning.

References

1. Singer BD, Corbridge TC. Basic invasive mechanical ventilation. South Med J 2009; 102(12):1238-1245.

2. MacIntyre NR. Evolution of the modern mechanical ventilator. In Hill N LM, editor. Ventilator management strategies for critical care. New York; 2000:37–52.

3. Mireles-Cabodevila E, Hatipoğlu U, Chatburn RL. A rational framework for selecting modes of ventilation. Respir Care 2013; 58(2):348-366.

4. Perez V, Pasco J. Less usual ventilatory modes I: MMV and AMV. J Mech Vent 2025; 6(3):132-137.

5. Chatburn RL, Liu PH. The evolution of intermittent mandatory ventilation. Respir Care 2023; 68(3):417–428.

6. Chatburn R, El-Khatib M, Mireles-Cabodevila E. A taxonomy for mechanical ventilation: 10 fundamental maxims. Respir Care 2014; 59(11):1747–1763.

7. Chatburn RL. Intermittent mandatory ventilation will live forever. Repir care 2016; 61(9):1281-1282.

8. Sanderson RR, Rogers C. History of intermittent mandatory ventilation 1971 to present. Part two. J Mech Vent 2022; 3(1):25-32.

9. Tobin MJ, Jubran A, Hines JE. Pathophysiology of failure to wean from mechanical ventilation. Schweiz Med Wochenschr 1994; 124(47):2139-2145.

10. Mireles-Cabodevila E, Diaz-Guzman E, Heresi GA, et al. Alternative modes of mechanical ventilation: A review for the hospitalist. Cleve Clin J Med 2009; 76(7):417-445.

11. Chatburn RL, Hatipoğlu. The evolution of intermittent mandatory ventilation: Update and implications for home care. Respir Care 2024; 69(11):1484-1486.

12. Chatburn RL. Classification of ventilator modes: Update and proposal for implementation. Respir Care 2007; 52:301-323.

13. Baum M, Benzer H, Putensen C, et al. Biphasic positive airway pressure (BIPAP) - a new form of augmented ventilation. Anaesthesist 1989; 38(9):452–458.

14. Salem SS, Hussein, Bada MS, et al. Biphasic positive airway pressure in the management of acute respiratory distress syndrome: a comparative study. Egypt J Bronchol 2023; 17(23):1-9.

15. Dräger Medical GmbH. Dräger Ventilation Mini Manual. Brief explanation of ventilation modes and functions 2015. Available at https://www.draeger.com/Content/Documents/Content/Draeger-Ventilation-Mini-Manual.pdf

16. Fajardo-Campoverdi A, Mireles-Cabodevila E, Medina A, et al. Update of the taxonomy of mechanical ventilation modes. Med Intensiva (Engl Ed) 2025; 49(10):502211.

17. Chatburn RL. Four truths of mechanical ventilation and the ten-fold path to enlightenment. J Mech Vent 2021; 2(3): 73-78.

18. Roth H, Luecke T, Lansche Get al. Effects of patient-triggered automatic switching between mandatory and sup-ported ventilation in the postoperative weaning period. Intensive Care Med 2001; 27(1):47-51.

19. Mireles-Cabodevila E, Siuba T, Chatburn RL. A taxonomy for patient-ventilator interactions and a method to read ventilator waveforms. Respir Care 2022; 67(1):129–148.

20. Getinge. SERVO-U Ventilator System v4.0, User's Manual. 2019. Available at https://www.getinge.com/dam/hospital/documents/english/servo-u-hands-on-guide-4.1-67374-en.pdf

21. Hendrix H, Kaisera ME, Yusen RD, et al. A randomized trial of automated versus conventional protocol-driven weaning from mechanical ventilation following coronary artery bypass surgery. Eur J Cardiothoracic Surg 2006; 29(6):957-963.

22. Chatburn RL. Classification of mechanical ventilators. Respir Care 1992; 37(9):1009-1025.