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Revised and 2nd Extended Edition

Understanding and comparing modes of ventilation

The Kronberg List of Ventilation Modes

Contents

Preface

Most of the attempts to find a common classification system for ventilator modes have ended in failure. This is particularly true for simplified classification systems that differentiate modes according to whether ventilation is "spontaneous", "pressure controlled" or "volume controlled", and which fail to include modern ventilation modes such as dynamic BiLevel, and closed-loop control modes such as IntelliVent ASV. The user of such simplified classification systems and their nomenclature will therefore find only limited information regarding a mode's suitability for different clinical scenarios. In an endeavour to provide our readers with a meaningful system of classification, we have settled on the following categories:

Volume-controlled ventilation modes
In volume-controlled ventilation, the ventilator delivers a pre-set tidal volume irrespective of airway resistance and lung elasticity. Actual ventilation pressures delivered will depend on airway resistance and compliance.

Pressure-controlled ventilation modes
In pressure-controlled ventilation, the inspiratory pressure (Pinsp) is kept constant. The actual tidal volume delivered is directly related to lung compliance.

Spontaneous ventilation modes
In patients unable to sustain unassisted breathing, spontaneous ventilation modes can support spontaneous breathing by keeping the alveoli open, or by reducing the patient's increased work of breathing.

Hybrid ventilation modes
Hybrid ventilation modes represent a technological advancement over pressure-controlled ventilation, and combine the known benefits of pressure-controlled modes of ventilation with the benefits of volume-targeted ventilation. Hybrid ventilation allows the user to set ventilation parameters in such a way as to create a 'safe window' within which pressure levels can adjust automatically in response to relevant changes.

Closed-loop ventilation modes
The term 'closed-loop' refers to a group of ventilation modes that use complex algorithms or different input variables. These allow ventilatory support to adjust automatically in line with the patient's needs.

We are of course aware that one commonly finds small differences in the specifications of seemingly similar modes of ventilation. Similarly, ventilation modes may be modified by changing parameter settings (e.g., PSV with a pressure support of 0 = CPAP). However, in order to make comparisons possible, all of these details have been carefully assessed and evaluated and, eventually, assigned to the appropriate categories.
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Comparison table: Parameters

Percentage of the delivered inspiratory **oxygen**	O_2	FIO_2	Oxygen
Inspiratory time of mandatory modes. Combined with the respiratory rate, it determines the inspiratory to expiratory time ratio (I:E) and the expiratory time. Both the respiratory rate and the inspiratory time affect the mean ventilation pressure.	Tinsp	Ti	T high
Upper pressure level applied in addition to PEEP	Pinsp	IPAP	P_I
Set pressure support applied in addition to PEEP level	PS	ASB	Psupport
The **tidal volume** is the set volume to be applied with each breath.	TV	VT	
As **bias flow**, the Byflow provides the set trigger flow and simultaneously presents a kind of "flow reservoir" for the spontaneously breathing patient. The Byflow function is available in all ventilation modes. The setting can be increased if the dynamic behaviour of the device is unsatisfactory during or after triggering with uncuffed tubes or if rebreathing of CO_2 is to be prevented when a ventilation helmet is used.	Byflow	Bias flow (auxiliary flow of gas)	Flowby

Expiration trigger in pressure support ventilation modes. The pressure-supported mandatory breath is terminated when the flow to the patient (measured in percent of the highest PS flow) drops to the specified PS end flow.	PS End-flow	E_{SENS}	ETS
Safety setting for pressure-support modes: **maximum duration** of the inspiratory phase during **pressure support** if the PS Endflow setting fails to trigger the switchover	PS TI max	Timax	
The "volume support" function determines the extent of the **compliance compensation**. The pressure support is proportionate to the inspiratory tidal volume.	Volume support	Volume assist	VA Max
The "flow support" function determines the extent of the **resistance compensation**. The pressure support is proportionate to the flow.	Flow support	Flow assist	FA Max
Weaning indicator. The measured parameter is the patient's maximum inspiration effort after a prolonged expiratory phase.	MIP	NIF	