# Synchronised Intermittent Mandatory Ventilation – A Technique to Assist Ventilation During Anaesthesia

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## Impact on Anaesthesia Practice

While new ventilation strategies are frequently introduced into pulmonary medicine, some modes do find their way into anaesthesia practice. Among the most recent additions to anaesthesia are pressure control ventilation, pressure support ventilation and synchronous intermittent mandatory ventilation (SIMV), the subject of this Clinical Focus, produced by the Department of Clinical Affairs.

First used to overcome patients who were 'fighting the ventilator', or to assist in weaning patients from mechanical ventilation in the intensive care unit, SIMV has evolved into an adjunct for both balanced and inhalation anaesthesia and is included on many newer anaesthesia ventilators. SIMV is designed to provide assured rates and tidal volumes in a manner that is not competitive to the patient's own spontaneous efforts.

By synchronising, the ventilator reduces both the tendency to fight the ventilator and the need for sedation or narcosis for the patient to be able to tolerate mechanical ventilation.

## How does SIMV differ from continuous mandatory ventilation (CMV)?

The most significant difference between CMV and SIMV is in the ability of SIMV to both sense and respond rapidly to a patient's own breathing efforts. In conventional CMV, historically employed as volume control ventilation (VCV), the ventilator initiates a time-cycled ventilation, irrespective of any patient-initiated breath. If a patient's breath happens to coincide with the mechanical ventilation, the impact may be minimal. On the other hand, when the mechanical ventilation interrupts a patient's own exhalation, the resulting abrupt and unexpected rise in airway pressure may produce conditions where the patient 'fights' the ventilator. This may also occur as the patient attempts to terminate a mechanical ventilation. Either condition may produce unacceptable ventilation, requiring additional intervention. Synchronising the patient's efforts with those of the ventilator provides a clinically significant advantage.

SIMV allows the ventilator to sense a patient's own breathing and permit spontaneous breathing between mechanical ventilations while ensuring sufficient mandatory breaths should the patient's own rate fall below a preset value. This combination can maintain a more appropriate minimum minute ventilation. Because of the synchronisation provided in SIMV mode, the ventilator will assist a patient's own breath when that breath falls within the synchronisation window as specified by the operator. These synchronised ventilations overcome difficulties experienced when patients attempt to compete with CMV mode ventilations.

## When is SIMV helpful?

The value of SIMV during anaesthesia differs slightly from the value this mode provides in the intensive care setting. In the ICU, SIMV has traditionally been used to wean a patient from mechanical ventilation. During anaesthesia, SIMV is used when a patient's respiratory rate or tidal volume change in relationship to changes in the depth of inhalation anaesthesia or when additional intravenous agents are administered in the middle of a general anaesthetic. SIMV allows the user to select a minimum mechanical ventilation rate as well as the minimum mechanical tidal volume. Patient-initiated breaths that occur outside the synchronisation window result in additional minute volumes in excess of the SIMV set minimum values. If, for some reason, the patient's own respiratory rate decreases, the ventilator will continue to provide the set tidal volume at the SIMV rate selected. In some ways, the use of SIMV in anaesthesia represents a back-up ventilation capability for spontaneously breathing patients.

During the course of general anaesthesia, various agents can affect the overall respiratory rate and volume. Among these are narcotics (decreased rate), inhalation agents (altered rate and tidal volume), neuromuscular blocking agents (decreased volume and rate), sedative (decreased rate and volume) or any combination of these drugs. The application of SIMV is well suited to managing these situations, providing for an assured minimum volume.

## How to Initiate SIMV

The use of SIMV is very similar to CMV. If implemented as SIMV (volume mode), an appropriate mandatory tidal volume and a minimum mechanical ventilation rate must be selected. This determines the minimum minute volume that the ventilator will provide. When selecting the ventilator rate, the patient's spontaneous rate must be considered.

If the SIMV rate is set at a high rate, which lowers the $PaCO_2$ below the patient resting $PaCO_2$, apnea will result, negating the benefit of SIMV. If the SIMV rate is set above the patient's own respiratory rate, the result is complete mechanical ventilation or CMV. The objective of SIMV is to provide a measure of ventilation back-up while permitting spontaneous breathing to continue.

Unlike volume control ventilation, setting an I:E ratio is not required. In SIMV, the inspiratory time is used to establish the timing of the breath. With spontaneously breathing patients, the I:E ratios will be altered as the patient's respiratory rate and rhythm change.

SIMV can be combined with pressure support ventilation (PSV) to provide both a back-up support ventilation strategy and may also be implemented as SIMV (pressure mode).

## Conclusion

Both inhalation and balanced general anaesthesia frequently allow patients to initiate breaths on their own. When patients are able to initiate breathing, the ventilator should allow such breaths without the concern that the patient will fight the ventilator or buck on the endotracheal tube. When a patient is able to breathe but has a decreased rate resulting from narcotic administration, SIMV provides a method of augmenting the respiratory rate.

SIMV is well suited to general anaesthesia when narcotics, relaxants or inhalation agents are employed to varying degrees during the course of the anaesthetic. ■