Aestiva®/5 New Modes: SIMV and PSVPro®

The Aestiva/5 Anesthesia System now provides the option of two ventilation modes designed to support patients who are able to breathe spontaneously during general anesthesia. These new modes, SIMV and PSVPro, complement the Aestiva’s existing volume and pressure modes, respectively.

This paper will provide an overview of these modes, changes that appear on the ventilator screen during their use, and an introduction to the ventilator settings used for both SIMV and PSVPro.

GE Healthcare believes these new ventilation modes will prove invaluable in today’s anesthesia practice.
Synchronized Intermittent Mandatory Ventilation, generally known as SIMV, permits both spontaneous breathing and mechanical ventilation by sensing a patient’s breathing efforts and synchronizing the user-set mandatory ventilations to conform to these efforts. Based upon the required mandatory ventilations, the new flow-triggering of the Aestiva identifies the onset of a patient’s spontaneous breath and delivers the tidal volume \( V_T \) for the duration of the inspiratory time \( T_{\text{insp}} \) set by the user. Between the mandatory ventilations the patient may continue to breath normally, rate and volume determined by the patient.

SIMV also provides mandatory ventilation should the patient not trigger a synchronized breath. Once the specified time has lapsed, the ventilator will deliver the user-specified \( V_T \) and \( T_{\text{insp}} \).

Irrespective of patient efforts, the ventilator will always deliver the required \( V_T \) and required rate established by the user.

The implementation of SIMV on the Aestiva also allows the use of pressure support for all the spontaneous breaths. This can be helpful in overcoming some of the work of breathing associated with patient breathing circuits and artificial airways.

For those situations when positive end expiratory pressure (PEEP) is needed, it can be added to the ventilation settings.

Pressure Support Ventilation (PSV) is implemented in the Aestiva as PSVPro, providing the additional safety of a mandatory ventilation backup should a patient’s spontaneous efforts cease.

When PSVPro is active, a user-specified pressure is applied by the ventilator when a patient’s spontaneous breath is detected. Using this support pressure \( P_{\text{support}} \), the patient is permitted to establish their individual frequency, inspiratory flow rate and inspiratory time.

Because PSV depends on breathing characteristics determined by the patient, the Aestiva employs PSV with an apnea backup, hence the term PSVPro. This apnea protection helps protect against situations that may decrease or terminate spontaneous breathing. Such situations may be the result of changes in neuromuscular blockade, the addition of narcotics, or deepening the level of inhalation anesthesia.
Understanding the settings in SIMV

SIMV settings are accessed through the Ventilation Mode window on the Aestiva. Once SIMV is selected the ventilator settings display will change to show the parameters used by SIMV. On initial selection, the \( V_T \) parameter will show dashes and will be flashing. The desired \( V_T \) should be entered and confirmed. Upon confirmation, SIMV is initiated.

Other parameter display areas also change once SIMV is initiated. Because this is a spontaneous mode there is no need to establish an I:E ratio, this will be determined by the patients breathing characteristics. In place of the I:E ratio is a value for the inspiratory time (\( T_{\text{inspired}} \)). This parameter permits the user to determine the amount of time during which each mandatory ventilation will be administered and may be set from 0.2 seconds to 5 seconds. If the user has entered SIMV from either volume ventilation or pressure control ventilation, the value for \( T_{\text{inspired}} \) will be determined from the I:E ratio from the previous mode.

To the right of the \( T_{\text{inspired}} \) value is the \( P_{\text{support}} \) parameter. This parameter has replaced the pressure limit (\( P_{\text{limit}} \)) parameter, though \( P_{\text{limit}} \) may still be set and is accessed through the SIMV & PSVPro Setup section of the Setup and Calibration menu.

\( P_{\text{support}} \) allows the user to specify the amount of pressure support the ventilator will add to each spontaneous breath and may help decrease the work of breathing produced by the patient breathing circuit and any artificial airway that may be in use.

SIMV permits the user to select the rate of mandatory ventilations from 2 to 60 per minute. This is different than the rates permitted in both volume and pressure control ventilation which allow rates ranging from 4 to 100 per minute.
Understanding the settings in PSVPro

Like SIMV, the settings for PSVPro are accessed through the Ventilation Mode window on the Aestiva. When PSVPro is selected the parameters specific to this mode are displayed. Upon entering PSVPro, the $P_{support}$ parameter displays dashes and is flashing. After selecting the desired $P_{support}$ and confirming the value, the ventilator will activate PSVPro.

Because PSV is a pure support mode for spontaneously breathing patients, PSVPro provides a protective mechanism should spontaneous breaths diminish or cease. Backup ventilation uses three additional parameters, inspiratory pressure ($P_{inspired}$), $T_{inspired}$, and Rate. These parameters should be adjusted to be consistent with current status of the patient.

$P_{inspired}$, $T_{inspired}$, and Rate are displayed in a font smaller than that used for both the $P_{support}$ and PEEP values and continue to be displayed in this smaller font until they are activated as a result of an apneic episode. As long as the patient continues to breathe as expected this apnea backup will remain available though not active.

Once apnea is sensed and the backup mode activated, these values are displayed in the normal font size, there is an audible alarm, a visual alarm stating “Backup Mode Active” and the ventilator will begin mechanical ventilation as determined by the backup mode parameter settings. This backup ventilation remains in effect until PSVPro is reinitiated by the user or until another ventilation mode is selected.
**SIMV/PSVPro Setup Menu**

While the most common parameters necessary to use both SIMV and PSVPro are accessible and displayed directly on the ventilator screen, there are additional parameters that permit even greater patient ventilation customization. These parameters are accessed through the SIMV & PSVPro Setup menu and include $P_{\text{limit}}$, Trigger Window, Flow Trigger, Inspiratory Termination and Backup Mode Active.

$P_{\text{limit}}$ establishes the maximum pressure permitted. Once this pressure is reached, the ventilator will immediately terminate the mechanical breath and cycle to the exhalation phase. When the $P_{\text{limit}}$ is reached there is an audible alarm and a visual alarm stating “High Paw”.

**Trigger Window**

The Trigger Window allows the user to specify the time during which the ventilator will watch for a spontaneous breath in order to deliver the synchronized ventilation. If no spontaneous breath is detected within the Trigger Window time, the ventilator will deliver the mandatory ventilation as established by the set parameters. Trigger Window can be set from 0% to 80% and reflects percentage of expiratory time measured backwards from the next mandatory ventilation. Adjusting the Trigger Window allows fine-tuning of SIMV to more fully complement a patient’s individual breathing pattern.
Flow Trigger

The Aestiva/5 has a Flow Trigger mechanism that permits the ventilator to sense a patient’s inspiratory effort. This is required to synchronize mechanical ventilation with spontaneous breathing. Adjusting the Flow Trigger from 0.2 to 10 liters per minute allows the user to specify how much effort is required to trigger the ventilator. In general this value is set to the lowest possible value to provide the greatest level of support during spontaneous breathing. This value may be set higher when breathing circuit leaks occur and auto-cycling results.

Inspiration Termination

Inspiration Termination is a PSVPro-specific parameter and may be adjusted from 5% to 75%. This parameter determines when a PSV ventilation should be ended based upon the inspiratory flow rate. (As an example, at the default parameter setting of 25%, the supported ventilation would be terminated when the inspiratory flow decelerates to 25% of the peak inspiratory flow rate. If the peak flow were 10 liters per minute, the ventilation would be terminated when the flow decreased to 2.5 liters per minute.)
**Backup Mode Active**

The last selection in the SIMV/PSVPro Setup Menu is the Backup Mode Active control. The “Pro” in PSVPro stands for “Protection”. An apnea backup is provided to protect patients during apneic periods while spontaneously breathing. The Backup Mode Active setting allows the user to set the amount of time between triggered breaths required to activate the backup mode. This value may be adjusted from 10 to 30 seconds, in increments of 5 seconds.

**CPAP**

Because PSVPro allows the user to set the pressure applied to the patient breathing circuit, it is possible to provide continuous positive airway pressure (CPAP). CPAP is activated by setting Psupport to 0 and setting the PEEP value to whatever the level of CPAP is desired. When using CPAP, backup ventilation remains available and the user may still customize the backup ventilation values as described before.

**Conclusion**

This paper is not intended to replace appropriate product training on the Aestiva/5 and users should receive this training before attempting to use these new features.

GE Healthcare is pleased to be able to offer these exciting ventilation modes and believes each of them will prove invaluable to the practice of general anesthesia.
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