ASV Quick Guide

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HAMILTON MEDICAL
Intelligent Ventilation since 1983

Warning

This Quick Guide is based on evaluations by clinicians within and outside Hamilton Medical and is intended to serve as an example. This Quick Guide does not replace either the official operator’s manual of your ventilator or the clinical judgment of a physician. This Quick Guide should not - on its own - be used for clinical decision making.

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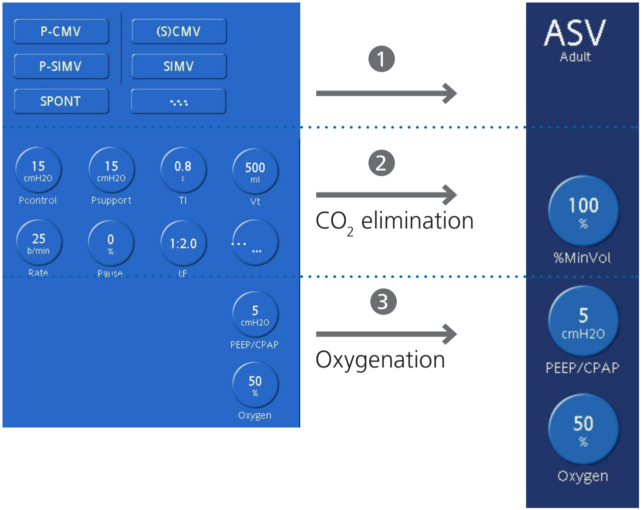
1. Adaptive Support Ventilation (ASV) basics



Conventional ventilation

ASV

ASV focuses on simplification of mechanical ventilation. This means:

1. Eliminating separate modes for passive and active patients
2. Reducing controls relevant for CO_2 elimination to just %MinVol
3. Adding direct access to controls relevant for oxygenation (PEEP/CPAP and Oxygen)

ASV maintains an operator-preset minimum minute volume independent of the patient‘s activity. The breathing pattern (tidal volume, rate, and inspiratory time) is calculated, based on the assumption that the optimal breathing pattern results in:

a. The least work of breathing
b. The least amount of ventilator-applied inspiratory pressure

A **lung-protection strategy** ensures ASV’s safety. ASV attempts to guide the patient using a favorable breathing pattern and avoids potentially detrimental patterns such as rapid shallow breathing, excessive dead space ventilation, intrinsic PEEP, barotrauma, and volutrauma.

2. Preparing for ventilation with ASV

Preparation

- Perform pre-operational check of the ventilator.
- Select accurate patient height and gender for the calculation of the ideal body weight (IBW).

3. Settings

ASV initial setup

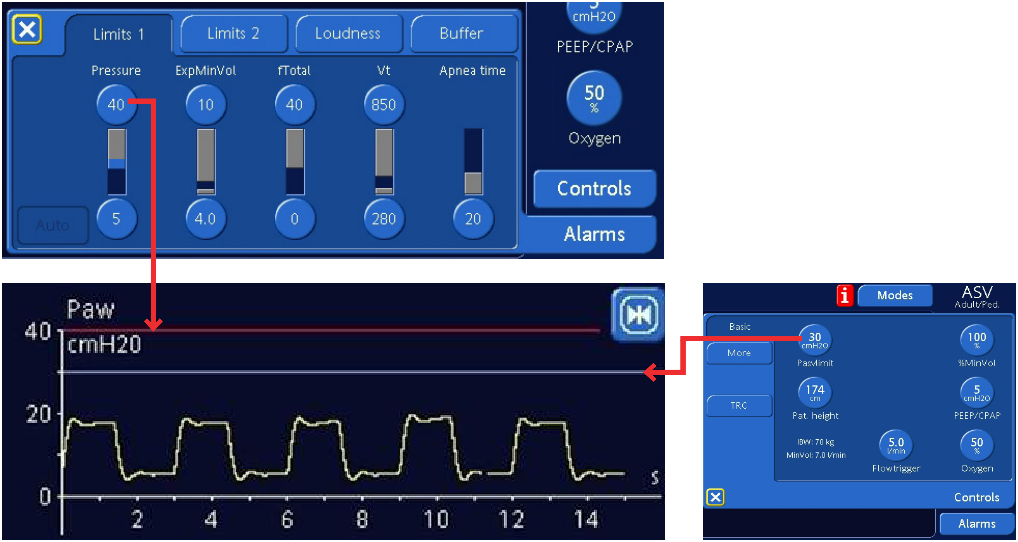
1. **%MinVol:** Suggested initial setting for a normal patient: 100% (ARDS: 120%)
   For adults, minute volume is calculated at 0.1 l per kg of IBW. For a patient with IBW = 70 kg, 100% MinVol results in 7 l/min, 50% MinVol is 3.5 l/min, 200% MinVol is 14 l/min.
   For pediatric patients, minute volume is calculated in a range from 0.3 l per kg for IBW = 3 kg to 0.1 l per kg for IBW = 30 kg.
2. **PEEP/CPAP:** Suggested initial setting: 5 cmH_2O (or according to your ICU standard)
3. **Oxygen:** Suggested initial setting: 50% (or according to your ICU standard)
4. **Controls:** In the Controls window, check the default settings. If required, adjust the following settings according to the patient's condition:

- Maximum pressure set by ASV (Pasvlimit). Default for normal patients: 30 cmH_2O
- Flow or pressure trigger
- Pressure ramp (P-ramp)
- Expiratory trigger sensitivity (ETS)

5. Connect the patient to the ventilator and touch **Start ventilation** to start

3. Settings

Alarms

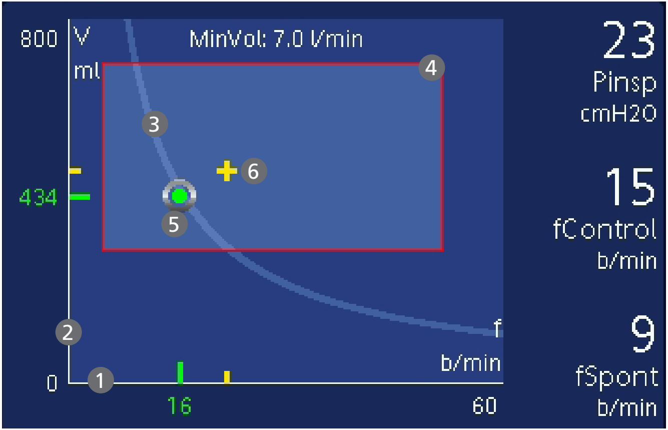


Check that the high Pressure alarm limit is set to an appropriate value.
Suggestions: Normal patient: 40 cmH_2O for 100% MinVol

The maximum inspiratory pressure delivered in ASV (Pasvlimit) will be **10 cmH_2O below the preset high pressure limit**, indicated by a blue band on the pressure curve graph. The maximum inspiratory pressure for ASV can be also set using the Pasvlimit control in the Controls window. Changing the Pasvlimit value also changes the high Pressure limit.

To avoid lung over distension, **check the Vt high alarm limit**, and make sure the target minute ventilation can still be reached in **passive** patients. Inspiration is aborted in mechanical breaths as soon as the volume exceeds 1.5 x Vt high alarm limit.

4. ASV graph

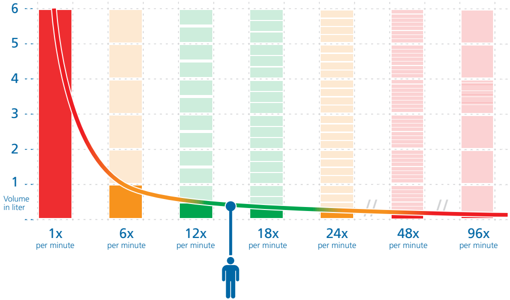


800
V
ml
MinVol: 7.0 l/min
434
0
16
60
f
b/min
1
2
3
4
5
6
23
Pinsp
cmH2O
15
fControl
b/min
9
fSpont
b/min

1. Horizontal axis for respiratory rate (f)
2. Vertical axis for tidal volume (Vt)
3. Minute volume curve – see next page
4. Safety frame in which target point may move
5. Target point, formed by intersection of target tidal volume and target rate
6. Current patient values, formed by intersection of measured tidal volume and current respiratory rate

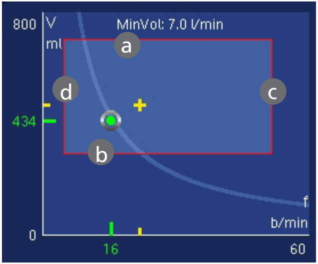
ASV adjusts the settings to guide the patient’s current values to the target point. This may be achieved for spontaneous breathing or passive patients. When the patient condition meets the target, the patient is considered optimally ventilated according to ASV. **It is not an indication of the patient’s clinical condition.**

5. Working principles of ASV



Optimal combination of tidal volume / respiratory rate
(in this example 15 x 400 ml for a minute volume of 6l)

Taking all possible combinations of respiratory rate and tidal volume into account, ASV calculates the optimal breathing pattern based on operator entries of **%MinVol** and the IBW, as well as on the measurement of **RCexp**. The device works on the assumption that the optimal breath pattern is identical to the one a totally unsupported patient will choose naturally (least work of breathing).



Lung-protective rules

ASV applies a lung-protective rules strategy to avoid

- a High tidal volumes and pressures
- b Low alveolar ventilation
- c Dynamic hyperinflation or breath stacking
- d Apnea

This lung-protection strategy ensures ASV's safety while it maintains an operator-preset, minimum minute ventilation independent of the patient's activity.

See Appendix I for detailed rules.

6. Monitoring ASV

Expiratory time constant (RCexp)

The expiratory time constant (RCexp) is a measure of how fast or slow the lung fills and empties. It is the product of compliance and resistance. Thus, this simple measurement assesses the two main characteristics of respiratory mechanics.

Why monitor RCexp?

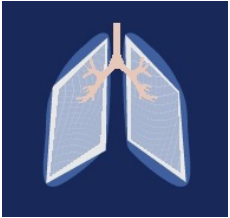
- RCexp is used as an input in ASV: if ASV selects an unexpected tidal volume-respiratory rate combination, checking RCexp helps to understand why.
- To understand the respiratory mechanics of the patient.
- To set the breath cycle: To have a complete expiration, expiratory time should be at least equal to 2 x RCexp

How is RCexp measured?

RCexp is measured breath-by-breath as the ratio between volume and flow during expiration. It is displayed in the Monitoring window, and is accurate in all breaths with passive exhalation.

Normal values in intubated adult patients

1. Short: < 0.6 s: restrictive disease: ARDS, atelectasis, chest wall stiffness
2. Normal: 0.6 – 0.9 s: normal compliance and resistance or combination of decreased compliance and increased resistance
3. Long: > 0.9 s: obstructive disease (COPD, asthma), bronchospasm, endotracheal tube obstruction or incorrect positioning



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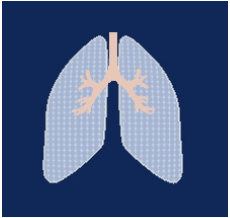

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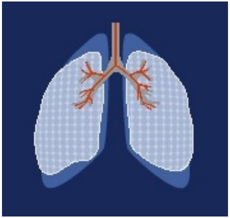

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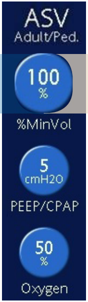
7. Adjusting ASV

Management of %MinVol

Passive patient

- If $PaCO_2$ is too high, increase **%MinVol**
- If $PaCO_2$ is too low, reduce **%MinVol**



Active patient

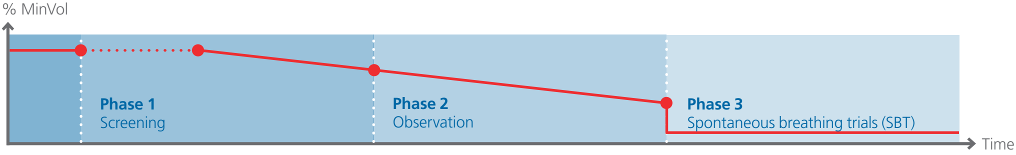
- If the patient is tachypneic and/or has a high respiratory effort, increase **%MinVol**
- If the patient's respiratory rate is lower or pressure support (Pinsp) is higher than desired, decrease **%MinVol**

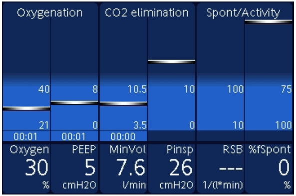
ⓘ Check blood gas analysis after 30 min, and adjust as needed

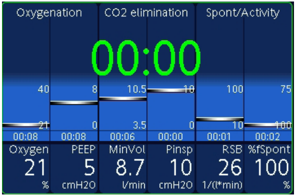
ⓘ The required **%MinVol** may be as high as 200%, but should not exceed 300%. If a very high **%MinVol** is required to meet the ventilation demand, consider using or increasing sedation, and control other factors such as high fever, sepsis, or metabolic acidosis. Except for some special cases such as hypothermia or chronic hypercapnea, a **%MinVol** lower than 100% is appropriate only for promoting spontaneous breathing activity.

Patient condition	%MinVol Adjustment
Patient is **passive** and has a **high $PaCO_2$** and very **low arterial pH**.	Increase %MinVol in steps of 10% – 20% to restore normal $PaCO_2$ and arterial pH.
Patient is **active** and continuously shows signs of **respiratory distress**.	Increase %MinVol in steps of 20%. After every step, wait for 2 to 5 minutes to observe the patient’s response.
Patient is **active**, but **spontaneous breathing disappears** or becomes **irregular**.	Reduce %MinVol in steps of 10%. Observe patient’s response after every adjustment.

8. Weaning in ASV







Phase 1 - Screening

If deep sedation is stopped and the patient is active, gradually reduce **%MinVol** (at most to 70% MinVol), **PEEP**, and **Oxygen** every hour.

Phase 2 - Observation

If the patient's respitory rate is < 30 breaths/min, **Pinsp** < 15 cmH_2O, **PEEP** ≤ 8 cmH_2O, **Oxygen** ≤ 40% or according to your ICU standard for 30 min to 2 h, consider an SBT.

Phase 3 - Spontaneous breathing trials (SBT)

Perform SBT. Suggested SBT settings:

PEEP = 5 cmH_2O, **Oxygen** = 30%

%MinVol = 25% for 30 minutes

If SBT is successful after 30 minutes and extubation criteria are fulfilled, consider extubation.

ℹ This protocol is our suggestion. You may have your own specific weaning criteria that patients have to fulfill before starting SBTs.

Appendix I

Lung-protective rules

A) High tidal volume limit

The tidal volume applied by ASV is limited by three operator settings: **Pasvlimit**, Vt high alarm limit, and IBW. The maximum pressure to be applied in the ASV mode is 10 cmH_2O below the high Pressure limit. Maximum tidal volume is limited by **(Pasvlimit - PEEP) x compliance.** In addition target volume is limited to **1.5 x VT high limit**, and pressure support is limited in such a way that the inspired volume does not exceed the **Vt high** limit.

B) Low tidal volume

It is widely accepted that a first approximation of dead space can be obtained by the following simple equation (Radford 1954): **VDaw = 2.2 x IBW**. The lower limit for tidal volume is based on this equation and calculated to be at least twice the dead space. The minimum Vt is **4.4 x IBW**.

C) High rate limit

The equation used to calculate the maximum rate is: **fmax = target MinVol / minimum Vt.**
To achieve a nearly complete exhalation to the equilibrium point of the respiratory system (90% of the maximum potential volume change), an expiratory time of at least **2 x RCexp** is theoretically

required. For this reason, ASV calculates the maximum rate based on the principle of giving a minimum inspiratory time equal to 1 x RCexp and a minimum expiratory time equal to 2 x RCexp, which results in these equations:

fmax = 60 / (3 x RCexp) = 20 / RCexp

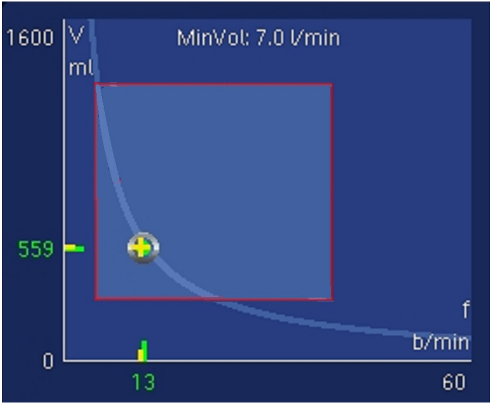
fmax ≤ 60 b/min

ASV always uses the lower of the two values. This limit applies to the respiratory rate of the ventilator only, not to the respiratory rate of the patient.

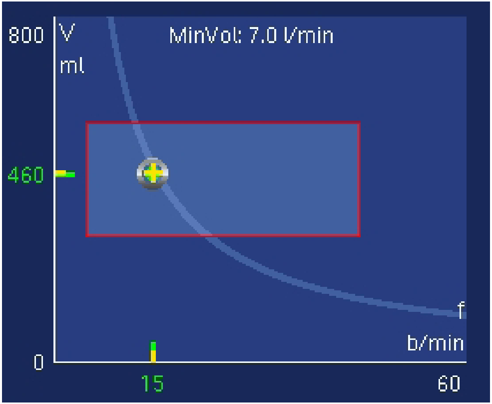
D) Low rate limit

The lowest target rate for adult patients is fixed at 5 b/min. For pediatric patients, the lowest target rate is in a range from 7.5 b/min for IBW = 30 kg to 15 b/min for IBW = 3 kg.

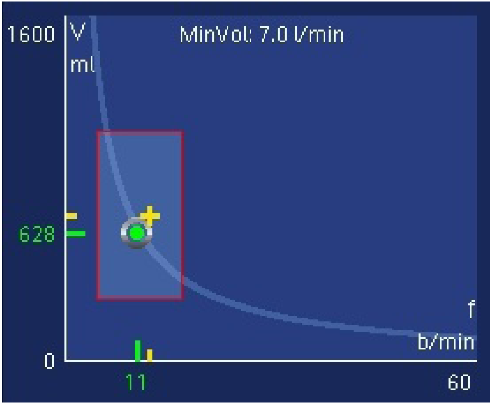
Appendix II
Understanding the ASV safety box

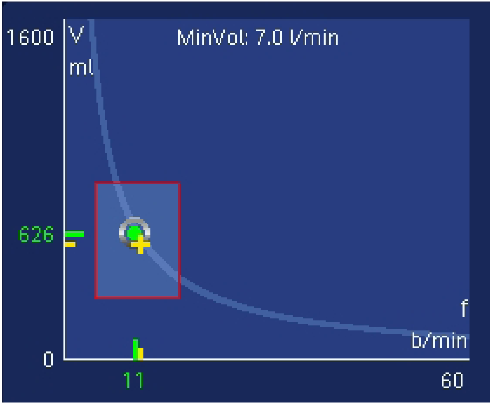


Wide square-shaped box: normal lung mechanics (**RCexp** = 0.6 s).



Low and wide box: low compliance or a «stiff» lung (**RCexp** = 0.3 s)





Narrow and high box: obstructions with long time constants and high resistance (**RCexp** = 1.2 s)

Low and narrow box: high resistance and low compliance (**RCexp** = 0.8 s)

Appendix III

Glossary

ASV	Adaptive Support Ventilation
ETS	Expiratory trigger sensitivity
FiO_2	Fraction of inspired oxygen
%fSpont	Spontaneous breath percentage
$PaCO_2$	Arterial partial pressure of CO_2
Pasvlimit	Maximum pressure set by ASV, always equal to **pressure limit -10**.
PEEP	Positive end expiratory pressure

Pinsp	Inspiratory pressure
%MinVol	Target minute volume on IBW ratio
RCexp	Expiratory time constant
RCinsp	Inspiratory time constant
RR	Number of breaths per minute
SBT	Spontaneous breathing trial

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