Measurement of AutoPEEP and total PEEP

In the presence of dynamic pulmonary hyperinflation, the average end-expiratory pressure inside the alveoli (i.e., the actual, total PEEP (PEEPtot)) is higher than the PEEP applied by the ventilator (PEEPe). The difference between PEEPtot and PEEPe corresponds with the intrinsic PEEP (PEEPi), and is also known as AutoPEEP (1).

AutoPEEP may also be referred to as air-trapping, breath stacking, dynamic hyperinflation, inadvertent PEEP, or occult PEEP.

AutoPEEP is a common phenomenon in mechanically ventilated patients with long expiratory time constants, for example patients with chronic obstructive pulmonary disease or acute severe asthma.

IMPORTANT: The resulting AutoPEEP cannot be seen on the airway pressure curve shown on the ventilator’s screen during normal breath delivery.

AutoPEEP and air trapping (2)
AutoPEEP predisposes the patient to increased work of breathing, barotrauma, hemodynamic instability and difficulty in triggering the ventilator. Failure to recognize the hemodynamic consequences of AutoPEEP may lead to inappropriate fluid restriction or unnecessary vasopressor therapy. AutoPEEP can potentially interfere with weaning from mechanical ventilation.

Caregivers should monitor whether AutoPEEP is occurring during ventilation, and set their ventilation control parameters accordingly to avoid the negative consequences of AutoPEEP.

All Hamilton Medical Ventilators have the unique capability of showing AutoPEEP as a monitoring parameter on a breath-by-breath basis. It is calculated using the LSF method applied to the entire breath (3). However in special circumstances for example when severe dynamic hyperinflation is present, the AutoPEEP calculated by LSF can underestimate the actual AutoPEEP. In these cases it can be obtained by performing an expiratory hold maneuver.

Measuring the total PEEP with an expiratory hold maneuver:

Ensure the Paw waveform is displayed.
Open the Hold window.
Wait until the Paw waveform plot restarts from the left side.
Wait for the next inspiration.
Then select EXP hold.
When the flow reaches zero, deactivate the hold maneuver by selecting EXP hold again. After the maneuver, the Hold window closes, and the freeze function is activated automatically.
Measure the total PEEP by examining points after flow reached zero on the pressure curve with the cursor. Calculate AutoPEEP by subtracting extrinsic PEEP from the total PEEP.

\[ \text{AutoPEEP} = \text{total PEEP} - \text{extrinsic PEEP} - \text{intrinsic PEEP} \]
Measuring the total PEEP using an expiratory hold maneuver
Total PEEP of 7.6 cmH2O - extrinsic PEEP of 5 cmH2O = AutoPEEP of 2.6 cmH2O

Expiratory times, lower respiratory rates and the use of sedatives can be necessary to avoid the dynamic hyperinflation caused by air-trapping.

All Hamilton Medical ventilators feature the intelligent ventilation mode Adaptive Support Ventilation (ASV®). ASV automatically employs lung-protective strategies to minimize complications from AutoPEEP.

Relevant devices: HAMILTON-G5/S1 (sw v2.6x); HAMILTON-C3 (sw v2.0.x), HAMILTON-C6 (sw v1.0.x)

References:
Iotti, G.A., Braschi, A., Measurements of respiratory mechanics during mechanical ventilation (Servizio di Anestesia e Rianimazione 1, I.R.C.C.S. Policlinico S. Matteo, Pavia, Italy). Hamilton Medical Scientific Library, Switzerland.