Experience with pressure supported Ventilation during General Anaesthesia

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Advantage of pressure support Ventilation (PSV)

The patients synchronize the respirator and not vice versa and they set the time for beginning spontaneous breathing themselves. Because of minimizing the work of breathing, spontaneous breathing under general anaesthesia is realized very simply. The airway-resistance and resistance of tube or laryngeal mask is getting over. Even pulmonary sick patients who are undergoing general anaesthesia benefit from pressure supported ventilation because you need less or no muscle relaxants and there is no fatigue of respiratory muscles. For optimal unloading of the respiratory muscles the ventilator should cycle in synchrony with the patient. Inspiratory end expiratory asynchrony causes discomfort and increased work of breathing. In intensive care medicine we know that this is associated with difficult weaning from mechanical ventilation. Atelectasis appears within 10 minutes in approx. 90% of all mechanically ventilated patients. With maintained motility of the diaphragm and spontaneous breathing the patient produces negative pressure in lower airways. With PSV and spontaneous breathing patients have less occurrence of atelectasis. In this way postoperative hypoxemia and pneumonia may be prevented under PSV.

The use of muscle relaxans to adjust the patient on the respirator is not necessary

With adequate use of PSV the use of muscle relaxant is much less than without, because of the patient’s synchronisation of the respirator. Together with relaxometry it reduces costs. Abdominal muscle-contractions are less with adequate pressure-support. The surgeons may close the abdomen without a further relaxation. Other aspects are minimizing hang over of muscle relaxans, time from end of surgery to extubation is shorter and the time in the recovery unit is reduced.

Diaphragmatic fatigue in healthy persons was induced by breathing through an inspiratory resistive load. The recovery in normal subjects starts to occur within the first few hours and is complete by 25 hours.

Travelin et al
Am. J. Resp. Crit. Care Med, Vol 156, Nr.5 1562 - 1566

Respirator setting

We use pressure controlled or volume controlled ventilation dependent on the patient and the surgery with PSV. With Avance Carestation normally a flow trigger between 0,6 to 0,8 l/min is chosen, the end of breath is adjusted at 30% of the peak-flow. A moderate PEEP is adjusted dependent on the airway-device (tubus or laryngeal mask) and the patient’s pulmonary situation.

Extubation during PSV

In dependence on the operation, the patient should breathe spontaneously for a long time before the extubation under pressure-support. The narcotic-agent-supply is discontinued shortly before end of the operation. If the patient could afford a sufficiently high minute-volume the PEEP is be increased shortly under a pressure-support, which evens out only the airway resistance in the breathing-system, before extubation. Then the patient is extubated under continuously mechanical-assisted ventilation. The pressure during extubation is exactly defined. There are not any agreement-problems between the person that extracts the tube and the person, which serves the respiration-bag and increases the pressure in the system. Since the flow-sensors of the respirator are very sensitive, the breathing-work caused through the circle-system is relieved of the patient through the pressure-support, and the patient becomes stress-free extubation.

A sensitive flow-sensor and a tight system are necessary for PSV

The in- and expiratory gas volume is measured 200 times a second. The flow-trigger is extremely sensitive and faster to patient response than pressure sensing. And the lowest changeable flow-trigger in this system is 0,2 l/min.

PSV (5 cm H2O and pressure support set 5 above PEEP) provides more effective ventilation while preserving leak fraction and hemodynamic homeostasis than CPAP set at 5 cm H2O

Goedecke et al
Anesth Analg 2005; 100: 357-60
Example 1
- 70 year old women
- Hip prosthesis
- Spontaneous breathing 18 minutes before extubation
- Total duration of surgery 57 minutes
- Pressure support 10 cm H2O
- Flow-trigger 0,8 l/min
- Extubation with PEEP 10 cm H2O
- Maximum flow during extubation 48 l/min

Example 2
- 72 year old man
- Resection of the prostate gland
- Spontaneous breathing 8 minutes before extubation
- Total duration of surgery 155 minutes
- Flow-trigger 0,8 l/min
- Pressure support 10 cm H2O
- Extubation with PEEP 20 cm H2O
- Maximum Flow during extubation 100 l/min

Depth of anaesthesia and spontaneous breathing

The two parameters Response Entropy (RE) and State Entropy (SE) are measured during general anesthesia. RE shows a fast reaction of activation of facial muscles and his activation is a hint for inadequate anesthesia. SE is smaller or equal to RE and is based on EEG-Signal. A value of 60 indicates a clinical relevant anesthesia, 40 and smaller pointed that awareness is improbable. Begin of spontaneous breathing depends on surgical stimulation, the use of muscle relaxans in intubated patients and the Setting of the respirator (frequency of mechanical ventilation, flow-trigger). The concentration of volatile anesthetics and analgesia with opioids has a big influence of suppressing spontaneous breathing.
Example 3
- 74 year old man, hydrocele
- Intubation with 8.5 mm diameter magill tubus
- RSI with 200 mg propofol, 0.1 mg fentanyl and 100 mg succinylcholine
- Duration of anesthesia 107 minutes
- Begin of spontaneous breathing 24 minutes after induction
- Adequate depth of anaesthesia under spontaneous breathing with 0.7 - 1.1 MAC of Sevoflurane

Economical aspects

*PSV improves gas exchange compared with spontaneous breathing and decreases leaks compared with positive pressure ventilation.*

Capdevila et al
Pressure support ventilation with laryngeal mask during general anesthesia, Anesthesiology 1995; 83: A 1226

The possibility of low-flow with 300-400 ml/min and the use of a laryngeal mask reduce costs of volatile anesthetics and medical gas. It is only necessary to use muscle relaxans for surgical reason. A short interval between end of surgery and extubation saves expensive time in the operation theatre. Because of the small volume in the ABS-circle-system the changing of volatile anesthetics-concentration is very fast.

Cost-Calculation of General Anaesthesia with Sevoflurane

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</table>

Cost-calculation for 1 hour general anaesthesia in low-flow mode
Laryngeal Mask and PSV

Laryngeal masks are used for general anaesthesia without muscle relaxant, often in children with mask induction. They are not as invasive as intubation. With this device the maximum airway pressure should not exceed 20 cm H2O. With assisted spontaneous breathing the patient generates negative airway-pressure and the respirator setting makes low flow possible. With the use of PSV are less volatile anaesthetics in the ambient air and the setting with PSV prevents the danger of hypoventilation.

Example 4
- Laryngeal mask in an 11 year old boy, weight 33kg
- PEEP 4 cmH2O, PSV 10 cm H2O
- Low-Flow anaesthesia with 400 ml/min fresh-gas
- Narcotic agent was Sevoflurane

PSV is better than CPAP in children under general anaesthesia with LM
- Children under PSV had lower ETCO2 than under CPAP
- The respiratory rate under PSV is slower
- The work of breathing is under PSV in small children 40% lower
- Under PSV the VtExp is higher
- PSV leads to higher airway pressure resulting in a higher lung volume

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