There has been a lot of research and discussion around intraoperative protective ventilation (PV) in the past years – for a good reason. Various studies demonstrated that PV approaches allow the reduction in incidence of postoperative pulmonary complications (PPC). With an incidence of approx. 5%, PPC are common complications in a broad, heterogeneous patient group.\(^1, 2\)

However, discussions on intraoperative protective ventilation has very much focused on parameters of mechanical ventilation, such as tidal volume, ventilation pressures, PEEP and recruitment maneuvers.\(^2, 3, 4\) One potentially influencing factor that should be included in the discussion is the humidification and warming of respiratory gas. In the ICU it is undisputed that respiratory gas conditioning is important to protect the lungs and is a universal standard of care.\(^5\)

**Temperature and humidity of the inspired gas**

For optimal gas exchange, the lungs require the inspired gas to be at a temperature of 37 degrees C and approx. 44 mg H\(_2\)O/l of absolute humidity (100% relative humidity). Under normal conditions, the respiratory tract warms the air during passage and the conditions described above are already met 5 cm below the carina.

During anesthesia, however, the upper respiratory tract is bypassed by endotracheal intubation or the placement of a laryngeal mask, leaving the lower respiratory tract potentially overcharged with the task of adequately acclimatizing the cold and dry gas applied during high flow anesthesia.\(^5, 6, 12\)

Mechanical ventilation with cold and dry gas may result in:

- Damage to the respiratory epithelium and reduced mucous transport, and may ultimately lead to complications such as infections and atelectasis\(^12-14\)
- Drops in body core temperature\(^7-11\)
- Increased risk for inflammation and subsequent harm\(^11, 15-18\)

**Benefits of low flow?**

Low-flow anesthesia is considered to be achieved at a fresh gas flow of 1 L / min, any higher fresh gas flow settings are considered high-flow. A general anesthetic with fresh gas flows of approx. 0.5 L / min is called minimal-flow anesthesia.

An absolute humidity of 30 - 35 mg H\(_2\)O/l is described as a target value for prolonged mechanical ventilation and a minimum of 15 – 20 mg H\(_2\)O/l to mitigate the risk of the negative effects that perioperative ventilation with unconditioned gas has on the airways.\(^6, 7, 11, 12, 14\)

In clinical studies on low- and minimal-flow techniques, values from 20 mg H\(_2\)O/l up to 30 mg H\(_2\)O/l and 32 degrees C could be well achieved.\(^7, 9, 11, 12, 19\)
The Clinical and Financial Benefits of Low Flow Anesthesia

General anesthesia using low fresh gas flows presents a variety of benefits, including:

- **Resource and cost savings**: The potential to save anesthetic gases, resulting in potential economic and ecological benefits.\(^{19}\)
- **Ease of use**: It is an effective and easy way to humidify respiratory gas.\(^{6,10,11,19}\)
- **Positive clinical effects**: Respiratory gas conditioning can be a component to avoid some of the potentially negative effects of ventilation with cold and dry gas.

It is important to note that low- and minimal-flow techniques place demands on the technology deployed. A list of technical requirements for the effective application of low- and minimal-flow technology can be found in our paper “Technology Insights.” For a more in-depth look at low- and minimal-flow anesthesia, you can also view our white paper on the Clinical Benefits of Low- and Minimal-Flow Anesthesia.

**References**

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