ASA/APSF Guidance for Use of Volatile Anesthesic for Sedation of ICU Patients

Emergency Use for the COVID-19 Pandemic

(Modified from a protocol produced by Brian O'Gara MD MPH, Assistant Professor of Anesthesia, Beth Israel Deaconess Medical Center, Department of Anesthesia, Critical Care, and Pain Medicine, Harvard Medical School)

Anesthesia machines have the capability of providing inhaled anesthetics for sedation during long-term care. While this might be an attractive option if intravenous sedatives are in short supply, it is not generally recommended when the machines are used as ICU ventilators for the following reasons:

- Inhaled anesthetics have profound physiological effects that can have a significant negative impact on critically ill patients
- Critical care nurses and intensivists are generally not familiar with dosing or monitoring the effects of these drugs
- Scavenging of exhaled gas is required when delivering inhaled anesthetics and may not be readily available outside of the operating room
- High fresh gas flows needed to prevent humidity from accumulating in the circuit will result in high anesthetic consumption and the need to frequently refill the vaporizer. Most of this anesthetic is vented to the atmosphere as waste gas, unabsorbed by the patient.
- Long term sedation with inhaled anesthetics is not a common practice in the United States although it has been used in other countries especially Europe for many years.

These considerations notwithstanding, if intravenous sedatives need to be rationed, it is possible to sedate patients being ventilated with an anesthesia machine by delivering inhaled anesthetics. Considerations for maximizing the safety and effectiveness of inhaled anesthetics when used for ICU sedation can be found in this document.

Data Supporting Volatile Anesthetic ICU Sedation:

The volatile anesthetic agents Isoflurane and Sevoflurane have been used safely for OR anesthesia for over 30 years. In the US, volatile anesthetic administration in the ICU has been largely for patients with refractory status asthmaticus or epilepticus.[3]

Long term volatile sedation would be an off label use of these drugs in the US. In Europe and Canada, critical care providers have been practicing long term volatile anesthetic sedation with either Isoflurane or Sevoflurane for nearly a decade. Experience in these locations suggests that these agents are effective sedatives with rapid on/offset and minimal metabolism and thus organ toxicity, even after multiple days of administration. Patients typically wake up quickly and have short times to extubation after sedative discontinuation as compared to other regimens including Propofol. This reduction in wake up and extubation times has been shown in isolated studies to translate to reduced ICU length of stay, although not consistently. A large scale randomized controlled trial in Germany has recently been completed, however results are not yet available.[4] A previous cohort study of 200 patients undergoing long term volatile sedation (>4 days) did not identify any increased risk of renal or hepatic injury with isoflurane.[5]

Lung Protection from the Volatile Anesthetics:

In addition to their bronchodilatory properties, the inhaled anesthetics may prevent inflammatory lung injury from a number of exposures as demonstrated in multiple preclinical models.[6] In human studies of lung cancer surgery patients, the use of sevoflurane as compared to propofol has been shown to reduce lung inflammation and prevent postoperative pulmonary complications.[7] In the ICU population, a pilot RCT of Sevoflurane vs Midazolam for 50 moderate to severe ARDS patients demonstrated lower concentrations of SRAGE and

improved oxygenation on day 2. Although the trial was not powered to detect differences in clinical outcomes, there were large non significant differences in VFD (13 vs 5.5d) and ICU LOS (18 vs 23d) favoring the Sevoflurane group. The effects of volatile anesthetics compared with intravenous sedatives have not been studied in patients with COVID-19; we do not know whether it will help, hurt, or make no difference with these patients.

Proposed Guidelines for Long Term Volatile Anesthetic Sedation in Critically Ill Patients

Patient Selection

Indications:

- Mechanical ventilation with need for sedation
- Intravenous sedatives unavailable or in short supply

Contraindications:

- Personal or family history of Malignant Hyperthermia (MH)[8]
    - MH is a genetically inherited condition where death can occur upon exposure to volatile anesthetics
- Known or suspected elevation in intracranial pressure
    - All volatile agents can elevate ICP via cerebral vasodilation
- Severe shock unresponsive to vasopressors
    - All volatile agents cause dose dependent hypotension, similar to propofol

Usage and Dosing

Agent Selection: Either Isoflurane or Sevoflurane can be used

- Isoflurane – less expensive, higher blood solubility, lower tissue solubility, less metabolized. Sevoflurane – more expensive, lower blood solubility and thus easier to make rapid adjustments, higher tissue solubility and thus accumulates during long-term administration, more metabolized which can increase fluoride levels during long-term administration.[9]

Administration

- Anesthesia vaporizer filled with liquid agent
- Anesthesia machine waste gas scavenger connected to suction or waste anesthetic gas disposal (WAGD) outlet, and set to appropriate flow rate to prevent room contamination.
- Vaporizer dial adjusted to insure the desired end expiratory concentration (%). Adjustment likely needed in the early phase of administration until the concentration reaches equilibrium.
- Reducing fresh gas flow (1-2 L/min at most) will conserve anesthetic agent, but is likely not feasible during long term mechanical ventilation due to moisture accumulation in the anesthesia machine. Experience to date suggests the need to set fresh gas flow to approximate minute ventilation, which will increase anesthetic consumption.

Dosing

- End tidal anesthetic concentration (%) should be used to guide dosing, not the the dial setting on the vaporizer
- End tidal anesthetic concentration monitoring is essential with low agent alarm enabled especially in patients receiving neuromuscular blockade to prevent awareness
- Titrate dosing to the minimal effective end-tidal concentration
    - Target RASS, Ramsey, etc
    - Ventilator synchrony
    - Patient comfort
    - Typical doses

Agent	Surgery Dose	ICU sedation range[9]
Isoflurane	1.2%	0.2 – 0.7%
Sevoflurane	2%	0.5-1.4%

Monitoring

- Recommend constant presence of anesthesia provider (anesthesiologist, CRNA, or CAA)
- Monitor vaporizer fill level and refill when below 20% of full
- Monitor inhaled anesthetic agent level with an anesthetic gas monitor, and enable the low-level alarm
- Monitor exhaled carbon dioxide (etCO2)
    - ETCO2 increases severely and acutely in MH
- Temperature monitoring
    - Anesthetics can lower core temperatures, and acute severe fever (>102F) occurs in MH
- Hemodynamic monitoring as per usual ICU care
- Consider regular serum Cr and LFT checks in long-term patients

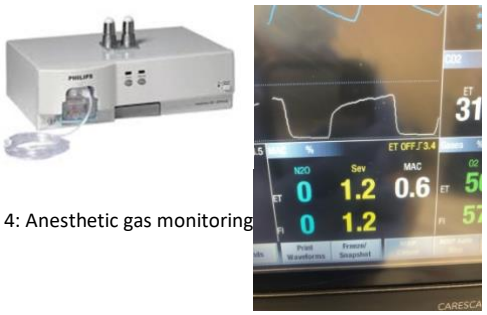

Figure 4: Anesthetic gas monitoring

Wake Up

Turn the vaporizer to zero and increase gas flows. Washout of anesthetic follows gradient from brain>blood>lungs. Patients typically able to be assessed/extubated within 10-15 minutes.

References

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