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Management of CO₂ absorbent while using the anesthesia machine as a mechanical ventilator on patients with COVID-19

O manejo do absorvedor de CO₂ durante o uso do aparelho de anestesia como respirador mecânico em pacientes com COVID-19

Anesthesia machine as a mechanical ventilator on COVID-19

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Dear Editor,

With the expansion of the COVID-19 pandemic, the world is experiencing a crisis related to lack of ventilators. In Brazil, it will not be different and maybe even worse. According to the Brazilian Critical Care Association (Associação de Medicina Intensiva Brasileira) census, there are roughly 42 thousand ICU beds in Brazil, albeit not all beds have mechanical ventilators.[1] Brazil has roughly 20 beds per 100 thousand inhabitants, a little less than Germany, which is the country with the best ratio in Europe, and in compliance with World Health Organization recommendations of 10 to 30 beds per 100 thousand inhabitants.[2] According to the Ministry of Health, over 20 thousand cases of COVID-19 were diagnosed in Brazil until April 12, 2020, but we lack data on Intensive Care Unit bed occupation.[3]

What is known is that many Intensive Care Unit patients will require mechanical ventilation. Retrospective data on Intensive Care Unit patients admitted with COVID-19 in Italy have shown that 88% of 1,590 patients required mechanical ventilation.[4] The United States, and
especially the state of New York, are the current epicenter of the pandemic. There, the deficit of mechanical ventilators is a major concern, and it can also be the case in Brazil.[5]

In order to try to minimize the deficit of ventilators, many groups of researchers, linked to the industry or not, are trying to develop new ventilators at a lower cost in a short period of time. However, the development of such equipment may take time due to the technical complexity and also because scale production is required. It is also important to underscore that currently we are facing a worldwide electronic component shortage crisis, which adds an extra caveat.

Bearing this scenario in mind, there is a proposal to use anesthesia machines as ventilators for COVID patients admitted to intensive care.[6] By using an anesthesia machine as a mechanical ventilator, with a high fresh gas flow (FGF), the CO₂ absorbent (soda lime) lasts longer and can be kept in the breathing circuit. However, one of the problems that can occur would be an extended period of ventilation, such as days or weeks, with low FGF use. The scenario would require the CO₂ absorbent (soda lime) to be replaced several times a day. Excessive soda lime consumption can lead to its shortage. In addition, during the CO₂ absorbent replacement procedure nursing and physiotherapy teams can be exposed.

Therefore, we performed several tests at the São Paulo University School of Medicine Anesthesiology Discipline Biophysics Lab (Laboratório de Biofísica da Disciplina de Anestesiologia da Faculdade de Medicina da Universidade de São Paulo) on a test lung with an injection of CO₂ (250 mL.min⁻¹) to detect scenarios of CO₂ rebreathing. Experiments were performed with the AVANCE S/5 (GE Healthcare,™ Chicago, US) anesthesia machine, with an empty absorbent reservoir (without soda lime) simulating ventilation with normal and low compliance lungs, 0.05 L.cm⁻¹ H₂O and 0.02 L.cm⁻¹ H₂O, respectively.

In order to test ventilation of the normal compliance lung the following parameters were used: Tidal Volume (TV) of 500 mL, respiratory rate (RR) of 12 cycles per minute, minute-volume (MV) of 6 L.min⁻¹ and PEEP of 4 cm H₂O. For the low compliance lung, parameters were: TV of 300 mL, RR of 40 cycles per minute, MV of 12 L.min⁻¹ and PEEP of 10 cm H₂O (Table 1). We started to change the FGF of the anesthesia machine and registered the inspired fraction of CO₂. We observed that when we used a FGF 20% higher than the adjusted minute-volume, no CO₂ was registered in the inspired gas, in both tests.

In face of the current crisis, we believe that using anesthesia machines for the management of critical patients with COVID-19 who require artificial ventilation would take some pressure off the strained health system. There are thousands of anesthesia machines distributed throughout the surgical blocks of Brazilian hospitals ready to be used.

Conflicts of interest
The authors declare no conflicts of interest.

References


Table 1 Ventilation parameters used in tests.

<table>
<thead>
<tr>
<th>Compliance</th>
<th>TV (mL)</th>
<th>RR (per minute)</th>
<th>MV (L.min⁻¹)</th>
<th>PEEP (cm H₂O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05 L.cm⁻¹ H₂O</td>
<td>500</td>
<td>12</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>0.02 L.cm⁻¹ H₂O</td>
<td>300</td>
<td>40</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

TV, tidal volume; RR, respiratory rate; MV, minute-volume.