Apneic Oxygenation

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Disclosures

• None

Objectives

• Review physiologic basis for apneic oxygenation
• Discuss guidelines for application of apneic oxygenation
• Provide evidence to consider adapting your practice to include apneic oxygenation

Steps in Anesthetic

• Transition from awake to anesthetized
• Patients respiration cease
• Most important goal during this process is maintaining oxygenation
• Typical scenario
  – Pre-oxygenation to denitrogenises the lungs and creates an alveolar oxygen reservoir
  – This oxygen reservoir provides apneic window in which attempts are made to secure an airway

Increase apneic window

• Preoxygenation
• Reduce dependent atelectasis through head-up position
• Raising mean airway pressure

Is there a way to increase apneic window during induction?

Steps in Anesthetic

• 12 “medium sized mongrel dogs”
• 45 minutes of respiratory arrest
• Airway kept patent
• 6-8 lpm of oxygen administered
Eight essentially healthy patients scheduled for variety minor procedures

Induced, intubated and then denitrogenated for 30 min

ETT, connected to circle apparatus, with 100% oxygen, and apnea was allowed to persist for 30-55 min

Reservoir bag

Moved -> more sure (avg 500mg)

Emptied -> refilled with O2 – required 2-3 liters q. 15 min

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**TABLE 1**

<table>
<thead>
<tr>
<th>Gas Exchange during apnea</th>
<th>Aventilatory mass flow (AVMF)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Number</strong></td>
<td><strong>Duration of Apnea (sec)</strong></td>
</tr>
<tr>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
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<tr>
<td>4</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>45</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
</tr>
</tbody>
</table>

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**APNEIC OXYGENATION IN MAN**

M. Jack Freiman, M.D., Robert M. Epstein, M.D., Gerald Cohen, Ph.D.

Accepted for publication June 25, 1959, presented at the Annual Meeting of the American Society of Anesthesiologists, Inc., Miami Beach, Florida, October 9, 1959. The authors are in the Departments of Anesthesiology and Biochemistry, College of Physicians and Surgeons, Columbia University, and the Anesthesiology Service, The Presbyterian Hospital, New York, New York.

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- Induced, intubated and then denitrogenated for 30 min
- ETT, connected to circle apparatus, with 100% oxygen, and apnea was allowed to persist for 30-55 min
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**Gas exchange during regular breathing**

*The effectiveness of apneic oxygenation during tracheal intubation in various clinical settings: a narrative review*

*Can J Anaesth (2017)*
Physiological effects
- reduction of anatomical dead space
- PEEP effect
- constant fraction of inspired oxygen
- humidification

THRIVE
- T - transnasal
- H - humidified
- R - rapid
- I - insufflated
- V - ventilatory
- E - Exchange

Extended apnea times in 25 patients with difficult airways (12 obese, 9 with stridor) undergoing hypopharyngeal or laryngo-tracheal surgery.
- Used HFNC oxygen, in 45º head-up position, initially for pre-oxygenation, and continuing during IV induction of anesthesia and neuromuscular blockade until a definitive airway was secured. Upper airway patency was maintained with jaw-thrust.
- The median apnea time was 14 min
- No patient desaturated < 90%.

The effectiveness of apneic oxygenation during tracheal intubation in various clinical settings: a narrative review
- 12 OR studies
  - Apneic oxygenation significantly prolonged the duration time to desaturation
- 5 ICU studies
  - 2 of 5 ICU studies showed significantly smaller decline in oxygen saturation
- 2 ED / prehospital studies
  - showed lower incidence of desaturation
### Apneic Oxygenation

The effectiveness of apneic oxygenation during tracheal intubation in various clinical settings: a narrative review

- **Conclusion**
  - 16 of 19 studies showed AO prolongs safe apneic time and reduces the incidence of arterial oxygen saturation.
  - Prolonged AO w/ resultant hypercarbia can have risks and should be avoided in conditions like elevated ICP, metabolic acidosis, hyperkalemia, and pulmonary HTN.

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<table>
<thead>
<tr>
<th>Paper</th>
<th>Design</th>
<th>Setting / Situation</th>
<th>Sample Size</th>
<th>Control Group</th>
<th>Apneic (AO) Oxygenation</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramachandra et al 2010</td>
<td>RCT</td>
<td>Elective Surgery w/ BMI 30‐35</td>
<td>30 = 15 control 15 intervention</td>
<td>No additional nasal O2</td>
<td>Nasal prongs at 5 L min</td>
<td>SpO2 &gt; 95%&lt;br&gt; AO: 5.29 min&lt;br&gt; Control: 3.49 min&lt;br&gt; Lowest SpO2&lt;br&gt; AO: 94%&lt;br&gt; Control: 87%</td>
</tr>
<tr>
<td>Christodoulou et al 2013</td>
<td>RCT</td>
<td>ASA 1‐3 Elective Surgery</td>
<td>41 = 14 control&lt;br&gt; intervention</td>
<td>No O2 insufflation</td>
<td>Nasal prongs at&lt;br&gt; 1) 5 L min&lt;br&gt; 2) 10 L min&lt;br&gt; Mean PaO2&lt;br&gt; &gt; 5 L min&lt;br&gt; &gt; no treatment</td>
<td></td>
</tr>
<tr>
<td>Lee et al 1998 RCT</td>
<td>ASA 1‐3 tympanomastoidectomies</td>
<td>46 = 23 control&lt;br&gt; intervention</td>
<td>No additional O2</td>
<td>Nasal prongs: O2 at 5 L min</td>
<td>Apneic for 3 min&lt;br&gt; PaO2 and less&lt;br&gt; PaCO2 increase</td>
<td></td>
</tr>
<tr>
<td>Patel et al</td>
<td>Prospective Study</td>
<td>Difficult Airways</td>
<td>23 male&lt;br&gt; 10 female</td>
<td>None</td>
<td>HFNC with O2 at 70 L min&lt;br&gt; 1) Median apnea time = 14 min&lt;br&gt; 2) No patient SpO2 &lt; 90%</td>
<td></td>
</tr>
</tbody>
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The anaesthetist should consider attaching nasal cannulae with 5 l min⁻¹ oxygen flow before starting pre-oxygenation, to maintain bulk flow of oxygen during intubation attempts.

### Guidelines

**Obstetric Anaesthetists’ Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics**

- Preoxygenation using a 20–25° head-up position and continuous positive airway pressure has been shown to delay the onset of hypoxia in obese patients.
- The duration of apnea without desaturation can also be prolonged by passive oxygenation during the apneic period (apneic oxygenation).
- This can be achieved by delivering up to 15 litres min⁻¹ of oxygen through nasal cannula, although this may be uncomfortable for an awake patient.
References


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References