Helium-Oxygen Gas Therapy*  
Use and Availability for the Emergency Treatment of Inoperable Airway Obstruction


Inoperable obstruction of the upper airway due to extrinsic malignancy may present as respiratory failure. We treated such a patient for 48 hours with 80 percent: 20 percent helium-oxygen delivered by a nonrebreathing mask while chemotherapy and radiation therapy reduced the tumor size. The need for intubation, mechanical ventilation, and high risk surgical intervention was avoided through the use of this gas therapy. We then surveyed San Francisco Bay area hospitals and found that fewer than one half could provide this potentially lifesaving gas therapy in an emergency situation. Physiologic basis of helium-oxygen gas therapy is reviewed and recommendations made for its use and availability.

Since 1935, when Barach introduced the use of mixtures of helium and oxygen (HeO₂) to reduce the work of breathing, the technique has been well described for use in infants with croup or difficulty in weaning from mechanical ventilation, but it has been used infrequently in adults. We recently treated a patient with severe airway obstruction from extrinsic compression of the trachea in whom the use of HeO₂ was lifesaving. In subsequent discussions among both physicians and respiratory therapists, we were struck by the lack of familiarity with the potential benefits and techniques of HeO₂ administration. We report the effective use of HeO₂ in one case, as well as the results of a survey that show the inconsistent availability of this gas mixture in San Francisco area hospitals.

CASE REPORT

A 16-year-old boy was admitted with one month of fever, weight loss, progressive exertional dyspnea, cough, and inability to raise pustum. Physical examination showed a jaundiced young man in mild nonstridorous respiratory distress with normal vital signs. Breath sounds were diminished but there were no rhonchi or wheezes. There were numerous subcutaneous nodules of the trunk, enlargement of the neck, diffuse lymphadenopathy, and bilateral testicular masses. Bone marrow biopsy revealed an undifferentiated malignancy.

The initial arterial blood gas values on room air were pH, 7.43; PaO₂, 72 mm Hg; and PaCO₂, 38 mm Hg. A posterior-anterior chest x-ray film (Fig 1) showed clear lung fields, bilateral pleural effusions, a mediastinal mass, and marked narrowing of the tracheal air column. A computerized tomographic (CT) scan (Fig 2) showed a

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REFERENCES


Chest 90: 3 / September, 1986 455

Figure 3. Apical four-chamber echocardiogram. Arrow points to echogenic mass in the left atrium.
tracheal lumen narrowed to 3 to 4 mm at the level of the second thoracic vertebra. Indirect laryngoscopy showed no abnormalities of the larynx; unfortunately, flow-volume loops were not obtained. Tracheostomy was considered technically impossible because of the location and extent of the obstruction. The patient complained of only mild dyspnea on exertion. Methylprednisolone was begun at a dose of 200 mg/day intravenously.

On the third hospital day, the patient developed severe respiratory distress with sustained tachypnea (32/min), stridor, and pronounced use of accessory muscles. He was given 100 percent oxygen by anesthesia mask but his arterial blood gas values steadily worsened (Table 1). Endotracheal intubation using the available pediatric diameter endotracheal tubes (3 to 4 mm OD) was thought to be technically impossible because of their short length. Plans were made to provide temporary extracorporeal membrane oxygenation.

At that point, a cylinder of 80 percent: 20 percent HeO₂ was obtained from the pulmonary function laboratory with the goal of reducing the density of the inspired gas. The HeO₂ mixture was administered via a tightly fitting nonrebreathing mask at a slow flow rate of 12 L/min (on a flow-meter calibrated for oxygen). The patient’s response was immediate and remarkable. Within two minutes of breathing this gas mixture, his respiratory rate decreased from 32 to 20 per minute, stridor diminished, and chest excursion increased. His arterial blood gas values promptly improved (Table 1) without other therapy.

During the next 48 hours, the patient received the HeO₂ mixture continuously along with supplemental oxygen. Chemotherapy and radiation therapy were begun for undifferentiated carcinoma. Aerosol treatments consisting of racemic epinephrine or terbutaline were started the evening after the patient began HeO₂ and were given as often as hourly to relieve episodes of acute respiratory distress and stridor. On the third day of treatment, he was successfully weaned from HeO₂. A chest x-ray film (Fig 3) taken one week after initiation of radiation therapy demonstrated resolution of the tracheal compression. He was discharged home two weeks after admission.

**Survey of Helium-Oxygen Availability**

By telephone call or personal visit, we surveyed the respiratory care departments of 41 San Francisco Bay area hospitals associated with the local chapter of the Managers Association of Respiratory Service. They were asked specifically: (1) is helium or HeO₂ available in your hospital for the emergency treatment of acute upper airway obstruction; and (2) is there a written protocol to guide the use of HeO₂? Of the 38 departments that responded (Table 2), only 17 departments (45 percent) had helium or HeO₂ available for emergency use and only four of these 17 (11 percent of total) had a written protocol to guide its use.

**Discussion**

When malignancies present as acute upper airway obstruction, endotracheal intubation or tracheostomy are usually technically possible. However, in a few cases the anatomy of the obstruction precludes these interventions. Endoscopic laser therapy may be lifesaving if the tumor is in

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**Table 1—Effect of Helium-Oxygen Therapy on Arterial Blood Gas Values**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Inspired Gas</th>
<th>pH</th>
<th>PaCO₂ (mm Hg)</th>
<th>PaO₂ (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/25/85</td>
<td>...</td>
<td>Room air</td>
<td>7.43</td>
<td>39</td>
<td>72</td>
</tr>
<tr>
<td>3/27/85</td>
<td>11:32 AM</td>
<td>100% O₂ by mask</td>
<td>7.17</td>
<td>75</td>
<td>207</td>
</tr>
<tr>
<td>11:54 AM</td>
<td>80%-20% HeO₂</td>
<td>7.36</td>
<td>51</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>12:23 PM</td>
<td>80%-20% + O₂ 2L/min*</td>
<td>7.32</td>
<td>45</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>12:34 PM</td>
<td>80%-20% + O₂ 2L/min*</td>
<td>7.31</td>
<td>49</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>1:31 PM</td>
<td>80%-20% + O₂ 2L/min*</td>
<td>7.34</td>
<td>44</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

*O₂ 2L is supplemental oxygen given by nasal cannula at 2L/minute.

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**Figure 1.** Admission PA chest roentgenogram taken on March 25, 1985. Note significantly narrowed tracheal air column (large arrow) at the level of the second thoracic vertebra as a result of compression by an extrinsic mass.

**Figure 2.** Computerized tomographic scan taken on March 26, 1985, shows the tracheal diameter to be narrowed to about 3 to 4 mm at the level of the second thoracic vertebra.

**Figure 3.** Follow-up chest roentgenogram taken on April 4, 1985, nine days after admission, demonstrates resolution of the tracheal compression after radiation therapy and chemotherapy.
The duration of observed flow in L × 1.8 where 1.9 is the conversion factor for a G cylinder. Despite its increased cost, for convenience and patient safety, we prefer the use of premixed HeO₂ to the alternative practice of mixing helium and oxygen at the bedside. If mixing is desired, flowmeters should be recalibrated for actual helium flow using a volume displacement spirometer.

**Table 2—Results of Survey of HeO₂ Availability in San Francisco Area Hospitals**

<table>
<thead>
<tr>
<th>HeO₂ in hospital</th>
<th>No. of Hospitals</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written protocol for HeO₂</td>
<td>17</td>
<td>44.7</td>
</tr>
<tr>
<td>No written protocol for HeO₂</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Written protocol but no HeO₂ in hospital</td>
<td>4</td>
<td>10.6</td>
</tr>
<tr>
<td>Neither HeO₂ nor written protocol</td>
<td>17</td>
<td>44.7</td>
</tr>
<tr>
<td>( n = 38 )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The use of HeO₂ in the emergency treatment of acute upper airway obstruction will rarely be necessary, but as the current case illustrates, it can be lifesaving. We believe that HeO₂ therapy, once considered a standard tool in respiratory care, should be available in all hospitals providing care for patients with upper airway obstruction. We learned that more than one half of the hospitals in our area would not be able to provide this emergency therapy using the resources in their institutions. To provide this therapy effectively, the gas mixture must not only be available, but there must be a clear, concise protocol for its emergency use.

**REFERENCES**