Minienvironmental Control under the Drapes during Operations on the Eyes of Conscious Patients

SIVAM RAMANATHAN, M.D.,* LEVON CAPAN, M.D.,* JACK CHALON, M.D.,† PETER B. RAND, B.A.,‡ GLENDA S. KLEIN, B.A.,‡ HERMAN TURNDORF, M.D.§

We have long been concerned about the environmental conditions that prevail under imprecise disposable drapes used for ophthalmic surgery. Weisman et al.† reported that significant carbon dioxide build-up occurred below the drapes. Jaffé‡ recommended insufflating 8 to 10 l oxygen/min in the vicinity of the patient's nose to prevent hypoxia and flush out exhaled gas. In a pilot study of 30 patients, we found that this flow of oxygen was insufficient either to reduce carbon dioxide concentration to less than 1.5 per cent or to alleviate the hot, humid conditions surrounding the subject's face. The addition of suction efficiently regulated the environment to within acceptable limits. We have, therefore, constructed a flexible hollow drape-supporting screen for use as both oxygen administrator and simultaneous gas evacuator. The characteristics of the device and its ability to create a satisfactory miniclimatic environment are described.

**Methodology**

A flexible corrugated metal tube (90 cm long and 1.3 cm ID) was welded at each end to a metal plate 10 cm wide and 15 cm long (fig. 1). The lumen of the tube was sealed off at the center. A series of holes, 3 mm in diameter and 3 cm apart, were drilled on either side of the center of the tube between corrugations.

The device was tested on seven consenting volunteers. A metal plate was placed under each shoulder with the corrugated tube forming a semicircular arch over the face. The center of the arch was brought to 15 cm above the bridge of the nose by judiciously flexing the device so that the central perforations faced downward. A humidity sensor attached to a Hy-
A Lyngdynamics® electric hygrometer indicator, a thermistor probe connected to a telemeter, and the sampling tube of a Goddard capnograph were placed on a wooden support 15 cm in front of the mouth of the subject and 21 cm in front of and below the apex of the corrugated arch. In addition, an Instrumentation Laboratories® oxygen analyzer was inserted in the sampling tube of the capnograph. A silica gel water eliminator was also placed in that tube windward to the oxygen analyzer.

Four sets of experiments were made in which the following measurements were carried out before and at stated intervals after draping the volunteers: 1) temperature; 2) relative humidity and absolute humidity calculated from relative humidity and temperature; 3) carbon dioxide and oxygen concentrations of ambient gas. The experiments were conducted as follows: 1) measurements under the drapes were made 15 minutes after draping without administering oxygen or applying suction; 2) measurements under the drapes were made 15 minutes after the introduction of dry oxygen (10 l/min) through the left lower end of the corrugated metal tube; 3) measurements under the drapes were made 15 minutes after the introduction of dry oxygen (10 l/min) and after another 15 minutes while continuing to administer oxygen but at the same time suctioning the right lower end of the corrugated metal tube at −50 torr; 4) measurements under the drapes were made 15 minutes after both administering oxygen and applying suction simultaneously from the onset.

Draping was performed by an ophthalmic surgeon using Johnson and Johnson Surgikos Split Sheet Disposable Drapes. The right eye was isolated as during operation by a 3M™ small-central-aperture Steridrape. All readings were made with the subject holding his breath for 10 seconds. The suction pump of the capnograph was activated only while oxygen and carbon dioxide concentrations were being measured. Results are expressed as the mean of seven readings ± 1 SD.

**RESULTS**

Temperature below the drapes was consistently above room temperature by 1.3 to 6.9°C (table 1). Similarly, absolute humidity was higher by at least 0.2 to 13.6 mg H₂O/l when the drapes were applied. Delivery of oxygen and suctioning during experimentation elevated oxygen concentration by 33.2 to 39.2 per cent and decreased carbon dioxide concentration by 2.2 to 3.3 per cent. Optimal results were obtained when suction and oxygen were used simultaneously immediately after draping (temperature and humidity 1.3 C and 0.2 mg H₂O/l, respectively, above ambient, respectively.

**TABLE 1. Temperature, Humidity, and Oxygen and Carbon Dioxide Concentrations in the Operating Room and Under the Drapes**

<table>
<thead>
<tr>
<th>Area Studied under the Drapes</th>
<th>Ambient (All instances)</th>
<th>After 15 minutes without oxygen or suction</th>
<th>After 15 minutes of oxygen only</th>
<th>After 15 minutes of oxygen followed by 15 minutes of suction</th>
<th>After 15 minutes of oxygen plus suction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (C)</td>
<td>25.7 ± 2.4</td>
<td>32.6 ± 1.4</td>
<td>31.5 ± 1.3</td>
<td>30 ± 2.5</td>
<td>27 ± 1.5</td>
</tr>
<tr>
<td>Relative humidity (per cent)</td>
<td>47 ± 4</td>
<td>73 ± 7</td>
<td>62 ± 10</td>
<td>56 ± 7</td>
<td>45 ± 0</td>
</tr>
<tr>
<td>Absolute humidity (mg H₂O/l)</td>
<td>11.4 ± 1</td>
<td>25 ± 1.5</td>
<td>20.5 ± 2.3</td>
<td>18.4 ± 1.6</td>
<td>11.6 ± 1</td>
</tr>
<tr>
<td>CO₂ concentration (per cent)</td>
<td>0</td>
<td>3.5 ± 0.3</td>
<td>1.3 ± 0.3</td>
<td>0.5 ± 0.2</td>
<td>0.2 ± 0.1</td>
</tr>
<tr>
<td>O₂ concentration (per cent)</td>
<td>20.8</td>
<td>17.4 ± 1.5</td>
<td>54 ± 6</td>
<td>60 ± 7</td>
<td>59 ± 1</td>
</tr>
</tbody>
</table>

* 1, without oxygen or suction; 2, with oxygen only; 3, with oxygen first and then suction; 4, with oxygen and suction from the onset. Measurements were obtained from seven volunteers. Numbers indicate means ± 1 SD.
carbon dioxide concentration only 0.2 per cent and oxygen concentration 59 per cent). The most unfavorable conditions were found when neither oxygen nor suction was used (temperature and absolute humidity 6.9 C and 13.6 mg H₂O/l, respectively, above ambient, carbon dioxide concentration 3.5 per cent and oxygen concentration 17.4 per cent).

**Discussion**

It is obvious from our findings that simultaneous administration of oxygen and suction immediately after draping effectively regulates the minienvironment around the face of the patient within satisfactory limits. When suction is applied too late it cannot sufficiently reduce temperature and humidity. This is partly due to condensation of exhaled moisture under the drapes. Increasing suction to more than −50 torr would probably be more effective, but at greater negative pressures a hissing noise disturbs the patient. When no measure is taken to increase atmospheric turnover under the drapes, the resulting hypoxia, hypercarbia, and high temperature-humidity index may cause restlessness, which interferes with the conduct of delicate operative procedures. Hypoxia is due partly to lack of efficient gas exchange and partly to increases in carbon dioxide and water vapor concentrations, which unfavorably offset the balance of partial gas pressures. An inhaled carbon dioxide build-up that exceeds 0.5 per cent may produce hypercarbia, which in turn can have adverse cardiovascular effects. Higher inhaled carbon dioxide concentrations may also increase retinal blood flow and intraocular tension and thus create unfavorable operative conditions. Since sedatives and/or narcotics are administered both pre- and intraoperatively in order to prevent restlessness, respiratory depression may occur. This is particularly the case for elderly arteriosclerotic patients, who often undergo operations on the eyes with local anesthesia. These drugs may interfere with the respiratory response to increases in inhaled carbon dioxide concentration, and severe hypercarbia may obtain.

The insufflation of oxygen at acceptable flow rates cannot in itself reduce the carbon dioxide and water vapor accumulation under the drapes. Moreover, the oxygen supply must be turned off when the electrocautery is used, to prevent flash fires. The addition of suction also increases the concentration of oxygen below the drapes, probably by improving cross ventilation.

The metal plates of our device were designed to prevent facial injuries to patients who raise their heads intraoperatively. Unlike fixtures attached to the operating table, the metal arch can freely rotate forward and thus move out of the patient's way.

**References**


Chloroprocaine Analgesia in a Patient Receiving Echothiohate Iodide Eye Drops

**JAY B. BRODSKY, M.D., MAJOR, MC,* AND FREDERICK A. CAMPOS, M.D., MAJOR, MC†**

The anesthetic chloroprocaine (Nesacaine) is hydrolyzed by plasma cholinesterase, an enzyme inhibited by

* Staff Anesthesiologist. New address: Department of Anesthesiology, Stanford University School of Medicine, Stanford, CA 94305.

† Resident Anesthesiologist.

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Chloroprocaine analgesia in a patient receiving echothiohate iodide (Phospholine iodide). We employed chloroprocaine for postoperative analgesia in a patient taking echothiohate eye drops and observed the onset and duration of the ensuing block.

**Report of a Case**

A 75-year-old woman weighing 60 kg was scheduled for vaginal hysterectomy and perineal repair. Her current medications included methyldopa (Aldomet), 500 mg three times a day; furosemide (Lasix), 40 mg daily; Dyazide (50 mg dyrenium and 50 mg hydrochlorothiazide), daily; and potassium supplement for treatment of hypertension. She had used echothiohate iodide (Phospholine iodide), 0.125 per cent, one drop in each eye twice daily, over a period of several years, for treatment of glaucoma.

In the operating room, diazepam, 5 mg, was given intravenously. A polyvinyl catheter was placed in the peridural space via the caudal