Effects of a Novel Noninvasive Open Ventilation System During Constant Work Rate Exercise in Patients with COPD

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Introduction: Exercise intolerance is a major limiting condition affecting patients with COPD. Consequently, the search continues for strategies that can enable these patients to more fully participate in everyday activities. Noninvasive ventilation has been shown to improve exercise capacity in severe COPD, but conventional systems are impractical for ambulatory use.1

We report the first physiologic study of a newly-marketed noninvasive ventilatory support device. Weighing about one-half kilogram and driven by the patient’s compressed oxygen supply, this system is practical for use during routine ambulation and for activities of daily living.

Methods: This was a randomized, single-blinded study of 10 male patients with moderate-to-severe COPD and desaturation during exercise. We evaluated a lightweight, wearable noninvasive open ventilation (NIOV) system (Breathe Technologies), designed for delivery of synchronized, augmented tidal volumes and oxygen using a nasal pillow interface (Figure 1).

Following a test day in which a cycle ergometer constant work rate (CWR) was established with exercise duration of 4-8 minutes, subjects completed 3 additional days in which 2-3 CWR tests (separated by 1.5 hrs) were performed in random order. Test conditions were: unencumbered room air, NIOV+Air, NIOV+O2, and O2 via standard nasal cannula. Data collected included exercise time, SpO2, transcutaneous TcPCO2, and the Borg Category Ratio (CR10) score to assess the subjects’ shortness of breath.

Results: Subjects’ ages were 67±9 yrs, with FEV1/FVC=29±6%, and FEV1=30±12% pred; peak work rate=53±23 Watts (W). The adjusted CWR to achieve an initial endurance between 4-8 minutes was 41±21 W (79% PWR). Compared to unencumbered and NIOV+Air arms, endurance was prolonged by ~75% with nasal cannula O2 and by ~330% with NIOV+O2. While both NIOV+O2 and nasal cannula O2 significantly improved SpO2, NIOV+O2 achieved significantly higher saturations than traditional oxygen delivery via nasal cannula. Oxygen delivery did not affect TcPCO2. NIOV+Air significantly relieved dyspnea at isoetime, while nasal cannula O2 and NIOV+O2 decreased dyspnea scores even further (Table 1, Figure 3 & 4).

Table 1. CWR Exercise endurance (41 ± 21 W, 79% PWR) and isoetime SpO2, TcPCO2, and Borg Dyspnea Scores (Mean±SD)

<table>
<thead>
<tr>
<th></th>
<th>Room Air</th>
<th>NIOV+Air</th>
<th>O2 Cannula</th>
<th>NIOV+O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endurance (min)</td>
<td>5.5 (2.3)</td>
<td>5.4 (2.0)</td>
<td>9.8 (6.7)*</td>
<td>17.2 (6.5)*†</td>
</tr>
<tr>
<td>SpO2 (%)</td>
<td>87.5 (2.2)</td>
<td>86.9 (3.9)</td>
<td>92.1 (4.7)</td>
<td>98.5 (1.1)</td>
</tr>
<tr>
<td>TcPCO2 (mmHg)</td>
<td>45.7 (7.6)</td>
<td>44.5 (6.5)</td>
<td>42.4 (6.5)</td>
<td>45.3 (6.1)</td>
</tr>
<tr>
<td>Borg Dyspnea Score</td>
<td>5.2 (2.2)</td>
<td>3.7 (1.9)*</td>
<td>2.7 (1.9)*</td>
<td>2.1 (1.3)*†</td>
</tr>
</tbody>
</table>

*One-way, RM ANOVA vs. Room Air and † vs. NIOV+Air (SNK P<0.05)

Conclusions: In this study, we demonstrated that in desaturating COPD patients using NIOV+O2, constant work rate exercise duration was increased dramatically; endurance time tripled over baseline and almost doubled over values achieved using standard nasal cannula oxygen. Dyspnea was significantly reduced by NIOV+Air and was further ameliorated by oxygen delivered via nasal cannula and NIOV+O2 at isoetime. Normalization of SpO2 was superior with the NIOV+O2 system compared to all other study treatments.

We believe these improvements are greater than have been reported for any other intervention with the exception of pulmonary rehabilitation, and provide evidence that the NIOV system is superior to traditional O2 therapy in improving exercise tolerance, shortness of breath, and oxygen saturation. These advantages are expected to allow severely debilitated oxygen dependent patients to achieve higher activity levels during daily life.

References:

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