Prolonged Rate of Decay of Arterial PO\textsubscript{2} Following Oxygen Breathing in Chronic Airways Obstruction\* 

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Nine patients with moderate to severe chronic obstructive lung disease were grouped according to results of pulmonary function testing. After a short period of 100 percent oxygen breathing, it took on the average 20 minutes (range —18 to 24 minutes) for their partial pressure of arterial oxygen to return to baseline levels. These data suggest that, after discontinuing supplemental oxygen in patients with chronic airways obstruction, more than 25 minutes should elapse if a blood gas measurement is to reflect with certainty conditions during room air breathing. 

It is frequently desirable to discontinue oxygen therapy and obtain an arterial blood gas measurement that reflects PO\textsubscript{2} while the patient is breathing room air. The question of how long to wait after discontinuing the oxygen has remained controversial. Howe and colleagues\textsuperscript{1} report elsewhere in this issue a study of serial blood gas measurements in patients with varying types of heart disease after discontinuation of supplemental oxygen. Virtually all of their patients had returned to baseline arterial PO\textsubscript{2} pressure (PaO\textsubscript{2}) within seven minutes after discontinuing oxygen breathing and most did so within the first five minutes. None of their patients had significant lung disease by history; pulmonary function tests were not performed. Massaro et al\textsuperscript{2} noted a variable rate of return of PaO\textsubscript{2} to baseline values after oxygen therapy was discontinued in patients with severe chronic obstructive pulmonary disease (COPD) with carbon dioxide retention. The process took up to 30 minutes.

We have studied a carefully characterized population with moderate to severe COPD, and observed that decay of PaO\textsubscript{2} to initial values after cessation of

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Tables 1 and 2, they are not included in the statistical analysis. Seven of the remaining eight patients had overdistended lungs with a mean percent predicted⁶ total lung capacity (TLC) of 134 and a mean residual volume to TLC ratio (RV/TLC x 100) of 69. The mean FVC was 52 percent of predicted. Physiologic dead space (Vd) and FRC were markedly elevated in all subjects. Expiratory flow obstruction was severe with all patients having a FEV₁.⁶ at or below 1 liter. The FEF₂₅-₇₅ percent was well below 1 liter per second in all subjects except patient no. 5. Mean resting steady state D₁ was 8 with a range of 5 to 11 ml/min/torr (normal >17). Tests of inspired gas distribution were severely abnormal. Mean values for single breath and 7-minute nitrogen washout determinations were 5.4 percent (normal <1.5) and 10.9 percent (normal <2.5 percent) respectively.

Following arterial cannulation, patients quickly came to resting steady state. The variation in resting baseline PaO₂ was small with a mean inter-sample difference of 1.0 torr (SD ± 1.0 torr). Seven of the nine subjects had resting room air PaO₂ of less than 60 torr. Eight of the nine had elevated PaCO₂ (>45 torr) at rest.

Table 2—Resting Arterial Blood Gas Determinations (Torr)

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Room air PaO₂</th>
<th>100% O₂ PaO₂</th>
<th>PaCO₂</th>
<th>PaO₂</th>
<th>Minutes after discontinuing supplemental O₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>69</td>
<td>53</td>
<td>518</td>
<td>153</td>
<td>107 85 78 75 72 69</td>
</tr>
<tr>
<td>2</td>
<td>69</td>
<td>51</td>
<td>518</td>
<td>83</td>
<td>71 68 --- --- ---</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>53</td>
<td>516</td>
<td>156</td>
<td>92 72 66 62 61 60</td>
</tr>
<tr>
<td>4</td>
<td>64</td>
<td>47</td>
<td>506</td>
<td>131</td>
<td>91 73 67 66 66 65</td>
</tr>
<tr>
<td>5</td>
<td>59</td>
<td>52</td>
<td>511</td>
<td>168</td>
<td>109 73 63 61 58 58</td>
</tr>
<tr>
<td>6</td>
<td>48</td>
<td>75</td>
<td>470</td>
<td>133</td>
<td>89 71 68 61 56 53</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>56</td>
<td>310</td>
<td>146</td>
<td>98 74 66 63 62 61</td>
</tr>
<tr>
<td>8</td>
<td>71</td>
<td>41</td>
<td>499</td>
<td>127</td>
<td>98 80 71 68 68 68</td>
</tr>
<tr>
<td>9</td>
<td>49</td>
<td>74</td>
<td>490</td>
<td>180</td>
<td>86 83 55 54 51 51</td>
</tr>
<tr>
<td>Mean</td>
<td>60</td>
<td>56</td>
<td>478</td>
<td>149</td>
<td>96 74 67 64 62 61</td>
</tr>
</tbody>
</table>

On 100 percent oxygen breathing all except subject 7 raised their PaO₂ near or above 500 torr (Table 2). Patient 7 had a repeat PaO₂ on 100 percent oxygen breathing of 510, and we presume leak of room air into the breathing circuit at the time of original study. Five of the nine subjects increased their PaCO₂ significantly (mean increase 10.2, range 4 to 16 torr) on 100 percent oxygen. In Figure 1, oxygen decay rate is shown as change in PaO₂ from baseline (± SD) plotted against time after discontinuation of supplemental oxygen. Initially the PaO₂ fell quickly; at four minutes all subjects had

![Image of graph](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/20963/ on 06/21/2017)
PaO₂ values of less than 200 torr. Most subjects required 20 minutes for their PaO₂ to return to baseline although subject 6 required 24 minutes. Subject 2 (status post-pneumonectomy) had the smallest FRC and, despite the presence of severe airways obstruction, returned to baseline in eight minutes. Our subjects had rather uniformly poor pulmonary function tests and all had prolonged oxygen decay rates. There were no significant relationships between any of the pulmonary function parameters and oxygen decay times.

DISCUSSION

Howe and colleagues, using supplemental oxygen via face mask in patients with presumably normal lungs, reported return of oxygen levels to baseline values within seven minutes of resuming room air breathing. In our population of severe COPD patients receiving 100 percent oxygen, the average time for return to baseline was 20 minutes with a range of 18 to 24 minutes. Although we used a high concentration of inspired oxygen, all PaO₂ values were 150 torr or less by the fourth minute after return to room air breathing. At four minutes the mean PaO₂ was 149 torr as compared with 229 torr at the start of decay in the data of Howe. Thus, the higher initial PaO₂ values attained in the present study appear to have contributed little to the much longer decay time in our subjects. Along the same lines, Massaro et al., studied six subjects with COPD receiving oxygen via nasal catheter at 1 to 2 liters per minute flow. They found that five patients took up to twenty minutes for PaO₂ to fall to baseline levels after discontinuing oxygen, but the sixth patient took 40 minutes to return to his resting level. It appears that factors such as severity of airways obstruction, intrapulmonary distribution of inspired air and size of FRC are more important than the inspired oxygen concentration.

Patients with COPD have many areas within their lungs with abnormal ratios of ventilation to perfusion. Overdistended areas that are ventilated poorly with diminished perfusion are cleared of nitrogen slowly on 100 percent oxygen breathing and likewise are cleared of oxygen slowly on return to room air breathing. Although there is a high oxygen gradient and driving pressure between these spaces and the arterial blood, low perfusion limits the amount of oxygen transferred. The high oxygen containing gas in these underperfused spaces can also move by diffusion and collateral ventilation into better perfused adjacent areas of lung. These air spaces are cleared of their high oxygen-containing gas slowly and provide a source or oxygen to the blood for a prolonged period of time.

We conclude that in patients with normal or near-normal lungs, seven minutes may well be long enough for PaO₂ values to have returned to baseline level. However, in patients with COPD who are receiving oxygen therapy, one should wait at least 25 minutes after resuming room air breathing if all patients are to have certainly returned to their baseline level.

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REFERENCES