A Design for Inhalation Therapy

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The purpose of this presentation is to describe a parallel piped oxygen and piped compressed air system for use in inhalation therapy, in patients with chronic pulmonary disease.

Intermittent positive pressure breathing (IPPB) with nebulized bronchodilator has been utilized widely in the treatment of conditions associated with disturbances in respiration. Subjective benefits and functional improvement have been reported to occur incident to this mode of therapy. Wu and her associates demonstrated that the greatest and most prolonged improvement of ventilatory function in patients with severe chronic pulmonary insufficiency or with excessive secretions was obtained by this method as compared with other methods of aerosolization.

Bronchial drainage is promoted by IPPB as a result of the rapid release of inspiratory pressure at the beginning of exhalation with a peak instantaneous inspiratory flow velocity. That the effectiveness of compressed

![Diagram of compressed air-oxygen system](attachment:image)

**FIGURE 1:** Plan of piped compressed air-oxygen system.

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air-activated IPPB in promoting gas exchange is related to increased ventilation even when an aerosolized bronchodilator is not simultaneously administered has been well demonstrated by Jameson and his co-workers.7

Fowler et al.8 concluded that oxygen-aerosolized isoproterenol (Isuprel) was superior to oxygen-intermittent positive pressure breathing alone and was as effective as the combined use of oxygen positive pressure and nebulized isoproterenol. Unfortunately, carbon dioxide contents or tensions were not measured in their study. These authors, however, recommended the use of IPPB in patients with marked hypoxemia and carbon dioxide retention.

Cullen and his co-workers9 have noted clinical worsening with increased hypventilation in some patients with carbon dioxide retention, when oxygen is employed to activate the IPPB apparatus. This has been noted by the present authors to occur in the presence of carbon dioxide narcosis.

Adjacent to the nontuberculous pulmonary disease section at the authors' hospital are a 3 H.P. pump and an oxygen manifold.10 Filtered (activated charcoal) compressed air is delivered in copper tubing at

<table>
<thead>
<tr>
<th>Gas Used</th>
<th>No. of Pts</th>
<th>Arterial O₂ Sat. (per cent) Before</th>
<th>Arterial O₂ Sat. (per cent) After</th>
<th>Arterial CO₂ Tension (mm. Hg.) Before</th>
<th>Arterial CO₂ Tension (mm. Hg.) After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>22</td>
<td>73</td>
<td>96</td>
<td>52</td>
<td>46</td>
</tr>
<tr>
<td>Compressed Air</td>
<td>15</td>
<td>77</td>
<td>83</td>
<td>57</td>
<td>48</td>
</tr>
<tr>
<td>30 per cent Oxygen</td>
<td>5</td>
<td>70</td>
<td>93</td>
<td>61</td>
<td>51</td>
</tr>
</tbody>
</table>

**FIGURE 2:** Wall-box with compressed-air and oxygen outlets.

††An NCG (National Cylinder Gas Company) Evenflow Control Unit Model 242-4 Manifold System.
approximately 70 pounds per square inch pressure. The oxygen is also piped through parallel tubing to wall-box type outlets in the various rooms (Fig. 1). Thus, each wall-box contains an outlet for oxygen and for compressed air (Fig. 2). The compressed air outlets are employed for positive pressure breathing therapy (Fig. 3) and for suctioning by means of Venturi-type attachments. The oxygen outlets may be used for conventional therapy or to supplement compressed air-activated IPPB when hypoxemia is not readily controlled by this therapy or by measures designed to improve the airways (nebulized detergents or enzymes, exsufflation, bronchoscopy, and occasionally, tracheostomy). This is done by attaching the tubing leading to the nebulizer to a regulator plugged into an oxygen outlet (Fig. 4).

The advantages of this system may be summarized as follows:

1. Improved patient care: the difficulties involved in securing adequate humidification when dry oxygen is employed have been well documented elsewhere. It is estimated that approximately 25 per cent of atmospheric humidity is delivered at the level of the wall outlets. Nevertheless, main-stream nebulization is employed, as recommended by Cushing and Miller, particularly when treating tracheo-
From Oz REGULATOR

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FIGURE 4: Oxygen-compressed air dilution for IPPB therapy.

tomized patients. In the authors' laboratory, 15 hypoxemic and hypercapneic patients exhibited an average rise of the arterial oxygen saturation from 77 to 83 per cent, and an average decline in the arterial CO₂ tension from 57 to 48 mm. Hg. after 20 minutes of compressed air-activated IPPB (Table 1). When oxygen is delivered through the nebulizer as indicated in Fig. 4, a mixture of approximately 30 per cent oxygen is delivered with an average rise in the arterial oxygen saturation from 70 to 93 per cent and a decline in the arterial CO₂ tension from 61 to 51 per cent as determined in five severely ill patients.

2. Safety and convenience: the bulky oxygen tank mounted IPPB units have been replaced by light-weight portable stands supporting these units, with elimination of noise, confusion, danger of oxygen tanks at the bedside and psychologic disadvantages to the patient.

3. Economy: the cost of compressed-air cylinders is prohibitive for routine use. Individual air-compressor driven IPPB units are noisy, particularly when several are simultaneously in use on the same floor. With the elimination of oxygen-activated IPPB, considerable savings have resulted. This can be readily appreciated when one considers the very high rates of flow (up to 130 liters per minute) delivered by the Bennett apparatus.

SUMMARY

A parallel piped compressed air and oxygen system for use in a chronic pulmonary disease section is described. The advantages in terms of improved patient care, safety, convenience, and economy are summarized.

RESUMEN

Se describe un aparato con tubos paralelos de oxígeno y aire comprimido para usarse en los enfermos con enfermedades pulmonares crónicas.

Se hace un resumen de su ventaja para la mejoría del enfermo, la seguridad, conveniencia y economía de su funcionamiento.
RESUMÉ

L’auteur décrit un système à tubes parallèles pour air comprimé et oxygène destiné au traitement des affections pulmonaires chroniques. Les avantages se résument en amélioration des soins donnés au malade, sécurité, commodité et économie.

ZUSAMMENFASSUNG


REFERENCES


SPONTANEOUS EOSPHAGO-BRONCHIAL FISTULA FORMATION
SURGICALLY TREATED IN A 90 YEAR-OLD

Successful surgical treatment of an esophago-bronchial fistula in a 90 year-old woman was accomplished with survival of the patient almost six years later at the time of this report. In view of a 59 to 88 per cent mortality rate recorded in conservatively treated cases and an 11.4 per cent mortality rate in surgically treated cases, the desirability of surgical treatment in even the poor-risk patient is emphasized. The fact that successful surgery of this type can be accomplished even in an aged patient presenting an extremely poor risk because of extensive cardiovascular disease is illustrated by this case. It is thought to involve the oldest patient undergoing successful surgical treatment for this condition recorded to date.