A SIMPLE AND INEXPENSIVE DEVICE FOR ADMINISTRATION OF CONTINUOUS POSITIVE AIRWAY PRESSURE BREATHING

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SUMMARY

A simple system for administration of continuous positive airway pressure breathing uses a corrugated hose in the modified Mapleson D system for anaesthesia. The only mechanical component of the system is a spring-loaded valve for positive end expiratory pressure.

Continuous positive airway pressure (CPAP) was introduced by Gregory and others (1971) in the treatment of neonates with respiratory distress syndrome (RDS). The method has been modified by Civetta, Brons and Gabel (1972) in the treatment of the adult RDS.

The positive pressure in the system depends on the flow rate and (expiratory) resistance. In adults with RDS, high flows of gas (15–20 litre min⁻¹) have been used to prevent rebreathing.

Considerable pressure variations have occurred in the systems previously described. Thus Andersen, Brøckner and Beck (1975) with a preset pressure of 10 cm H₂O found a variation of 8–10 cm H₂O.

The present system has been designed to reduce pressure variation and avoid rebreathing in a simple system.

METHODS AND RESULTS

Fresh gas passed from a flowmeter through the central part (F) of a coaxial hose with a modified Mapleson D system (Bain and Spoerel, 1972) (fig. 1). The gas outlet was placed as close as possible to a mouth-piece (A) with sampling sites (S) (for pressure and carbon dioxide measurement). Expired gas and excess fresh gas were led through the external part of the coaxial hose. The other end of the hose was connected to a spring-loaded expiratory valve (V) with a variable-resistance (PEEP-valve, Ambu International) and a latex-rubber bag (R) with the volume of 5.5 litre.

The coaxial hose acted as a one-way valve and, in combination with the bag as a pressure buffer, reduced pressure variations during inspiration and expiration.

The original length of the coaxial hose (130 cm) reduced the role of the bag as a pressure buffer because of the flow resistance in the hose. Therefore the hose was shortened to 40 cm. In our experiment flow was kept constant at 15 litre min⁻¹ and variation in pressure was made only by changing the expiratory resistance. The overall volume of the system was 5.7 litre. The volume of the coaxial hose was 0.15 litre.

Pressure was measured at the mouth-piece with a Statham PT5C differential pressure transducer connected to an amplifier (Ellab type M5 BCM A). Carbon dioxide concentration was measured with an infra-red carbon dioxide analyser (Capnograph, Godart–Mijnhardt). Both measurements were recorded on a three-channel recorder (Mingograf 34, Siemens–Elema). Pressure variations were measured over at least 15 breaths. Mean pressures were calculated by planimetry.

The system was tested on eight healthy adult volunteers (four men and four women). Before the investigation each subject received instruction to ensure normal breathing and correct application of the mouth-piece and the nose-clip.

Static pressure was preset at 7.5, 10 and 15 cm H₂O respectively by variation of the expiratory resistance with the mouth-piece closed.

Fig. 1. CPAP breathing device: A = mouth-piece; S = sampling sites for pressure and carbon dioxide monitoring; B = coaxial hose; F = central part of coaxial hose; V = spring-loaded expiratory valve; R = expandable rubber bag.
TABLE I. Results in eight adult volunteers. The range of pressure was measured over a minimum of 15 breaths. 

<table>
<thead>
<tr>
<th>Subject no.</th>
<th>Range</th>
<th>( \Delta p )</th>
<th>Mean</th>
<th>Range</th>
<th>( \Delta p )</th>
<th>Mean</th>
<th>Range</th>
<th>( \Delta p )</th>
<th>Mean</th>
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<td>7.2</td>
<td>8.0-10.8</td>
<td>2.8</td>
<td>9.6</td>
<td>13.0-15.0</td>
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<td>14.4</td>
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<td>7.6</td>
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After presetting the respiratory resistance the volunteer breathed for 5 min at pressures of 7.5 and 10 cm H\(_2\)O and for 10 min at a pressure of 15 cm H\(_2\)O before measurements.

The inspiratory and expiratory concentrations of carbon dioxide were constant throughout.

Pressure variations and calculated mean pressures are shown in table I.

DISCUSSION

The largest differences between inspiratory and expiratory pressure were found at static pressures of 7.5 and 10 cm H\(_2\)O, while the differences at a static pressure of 15 cm H\(_2\)O were significantly smaller (\(P<0.01\) Pratt's test). This was probably a result of the compliance of the rubber bag.

Acceptable mean pressures were obtained with the present system. Furthermore, pressure variation during breathing was minimized compared with other systems (Andersen, Breckner and Beck, 1975). In the treatment of adults with RDS it has been the practice to use greater pressures in CPAP breathing. Thus the very small variations in pressure (2-3 cm H\(_2\)O) at a static pressure of 15 cm H\(_2\)O adds further advantage to the system.

Apart from the bag, the system may be assembled easily from commonly available components. For clinical purposes a humidifier should be added and it is suggested that pressures be recorded with a simple anaeroid manometer.

REFERENCES
