bromide salts indicates that he would have appreciated the underlying physicochemical processes. He met Hill and Adamson in York and had a keen interest in enlargement of the thyroid. It is thus tempting to try to link Inglis with the picture of the goitrous woman taken in Edinburgh. He maintained his contacts with that city and his brother-in-law, Dr. Charles Ransford, was treasurer of the Royal College of Physicians of Edinburgh from 1842 to 1851. However, no certain connexion has been traced so far between Inglis and the clinical photograph, and who arranged for it to be taken remains a mystery.

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New Appliances

New Method for Oxygen Therapy in the Home using an Oxygen Concentrator

R. D. STARK, J. M. BISHOP

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Summary

Patients with pulmonary hypertension due to chronic bronchitis may improve during long-term treatment with oxygen. The methods of administration which are currently available are expensive and present practical difficulties. The Rimer-Birlec domiciliary oxygen concentrator produces an oxygen concentration of 92% at a flow of 2 l./min. It has been used successfully in a patient's home but further use will require an increase in mechanical reliability and a decrease in noise. In view of its convenience and the economic advantages the oxygen concentrator is an important advance in treatment with oxygen and could prove to be the method of choice in the home.

Introduction

Patients with chronic bronchitis may develop pulmonary hypertension and congestive cardiac failure. The pulmonary hypertension has been reversed with oxygen, sufficient to correct the hypoxaemia, administered for 24 hours daily[1] and 15 hours daily.[2] Discontinuance of the treatment with oxygen led to a return of the pulmonary hypertension within several weeks.[1] We believe that maintained reduction of the pulmonary arterial pressure is accompanied by an improvement in the clinical condition with fewer episodes of congestive cardiac failure. This is at present being tested by administration of oxygen to patients in their homes. Oxygen is supplied for 15 hours daily through nasal catheters (Pharmaseal K 29) at a rate of 2 l./min.[2] The use of oxygen cylinders may present difficulties in delivery and storage and is costly.

Study of other methods of supply led us to consider the Rimer-Birlec oxygen concentrator. This was first described by Cooper[3] in a form suitable for small hospitals. Cotes *et al.*[4] studied an oxygen concentrator produced by the same manufacturer which supplied oxygen at a concentration of 60% and at flow rates up to 28 l./min. At our request a new prototype has been produced (DOM-OC-5L), designed for use by a patient in his home.

The concentrator separates nitrogen from oxygen in air by preferentially retaining molecules of the former on the surface of a molecular sieve, as in gas chromatography. The molecular sieve is contained in canisters into which compressed air is admitted. Oxygen-rich gas leaves the canister early in the cycle and the nitrogen remaining is released to the atmosphere. Two canisters are used, the period of oxygen outflow from one coinciding with the discharge of nitrogen from the other, so that a continuous supply of oxygen-enriched gas is delivered to the storage vessel.

Results

The DOM-OC-5L measures 64 by 69 by 102 cm and weighs about 100 kg; it is mobile on castors. There are three simple controls—a mains switch, an oxygen cock, and a valve for adjustment of flow. The power is supplied from mains electricity,

Department of Medicine, University of Birmingham, Queen Elizabeth Hospital, Birmingham B15 2TH
R. D. STARK, PH.D., M.R.C.P., Research Fellow
J. M. BISHOP, M.D., F.R.C.P., Professor of Medicine

the consumption being 1 kW (240 V, 50 Hz). The air inlet and waste outlet are inside the cabinet and necessitate adequate ventilation while the machine is running.

Over a period of 16 months the oxygen concentrator ran for about 2,500 hours. The general running was satisfactory but three breakdowns were due to faults in the compressor, and this has now been replaced. The compressor and vacuum pump are both noisy, and in spite of several modifications the level of noise is not sufficiently low for use inside the house.

Flows up to 6 l./min can be obtained; later models will have a maximum flow of 2-3 l./min, and this should permit reduction in the overall size of the concentrator. The oxygen concentration measured both by a paramagnetic oxygen analyser (Servomex Controls, Limited) and by Scholander gas analysis was 92% when the flow was 2 l./min and fell to 81% at 3 l./min. After the build-up from 21% to 80-90%, which occurred over 20 minutes, the concentration of oxygen remained virtually constant for periods up to 16 hours, which was the longest time tested. From day to day the oxygen concentration at 2 l./min did not vary by more than 2%.

The composition of the gas mixture delivered by the oxygen concentrator was first measured by the usual chemical methods (Scholander microanalyser) and no carbon dioxide was detected. Further analysis by gas chromatography and mass spectrometry showed that apart from oxygen the mixture contained nitrogen and argon. Traces of carbon dioxide and water vapour but no undesirable component such as carbon monoxide or oxides of sulphur or nitrogen were detected.

The DOM-OC-5L was used in the home of a patient for eight months. In view of the noise it was installed in a garage and the oxygen led to the house through polyethylene tubing (internal diameter 4 mm). No decrease in flow occurred with these extensions, which had outlets through twin nasal prongs (Pharmaseal K 29) in the bedroom and living room. Some nasal discomfort was experienced when the oxygen concentrator was first used but this was abolished by passing the oxygen through a water trap, which is thoroughly cleaned and disinfected every three days. A flow rate of 2 l./min (oxygen concentration 92%) was used, and on two occasions this was shown to produce an arterial Po_2 similar to that while breathing 100% oxygen at the same flow rate. The improvement in the general condition of this patient, which was first established by oxygen delivered from cylinders, was maintained during the eight months the oxygen concentrator was in use and he continued to work full-time.

The running cost was about £1 a week at the minimum rate of charge for electricity. No interference with radio or television was reported in the home of the patient or of his neighbours.

Discussion

At present the only method readily available for administration of oxygen in the home is by use of cylinders containing 48 ft^3 (1·4 m^3) of oxygen. The therapeutic regimen which we consider necessary (2 l. of oxygen/min for 15 hours a day) requires about 10 cylinders each week provided no leakage occurs. This necessitates either considerable space for storage or more than one delivery each week. Furthermore, the handling of cylinders and the frequent changing of the reducing valve may present problems to a patient handicapped by dyspnoea or to members of his family. Such treatment is expensive, and according to the recent Drug Tariff the cost for one year would be about £1,000. The use of 120-ft^3 (3·4-m^3) cylinders of oxygen reduces the cost to about £600 and is practicable provided there is easy access to safe storage space, but the handling difficulties remain.

The use of a liquid oxygen system has been investigated in the United States by Petty *et al.*[5 6] The apparatus consists of a portable "walker" and a reservoir which contains a supply for three to four days. Regular deliveries are required as for cylinders and this contributes appreciably to the cost. Equipment of this kind is not currently available in Britain, but the cost of a year's treatment in the United States is about £500.[5 6]

The oxygen concentrator has advantages over both these methods. There is no problem with delivery and operation requires only a source of electricity. The initial cost of the production model is likely to be relatively modest, and the service and maintenance costs based on the stated performance of the components should not prove expensive. The electrical supply costs about £50 a year, and this will probably be reduced in later, smaller models. If the capital costs were to be spread over five years the total yearly cost of treatment would be less than £200.

These considerations assume that the patient does not need a supply of oxygen when he is walking and away from home. The regimen we are using requires oxygen for 15 of the 24 hours, and patients treated in this way are able to arrange their activities so that a supply of oxygen is seldom required outside the home. For patients who do require a supply for ambulation the liquid oxygen system may prove most suitable although by no means ideally convenient.

With regard to safety there seems little difference between the three methods. All carry the hazards associated with locally high concentrations of oxygen if the simple common-sense precautions are not taken.

The Rimer-Birlec domiciliary oxygen concentrator is a promising development for long-term treatment with oxygen. At the low flow rates required by patients with chronic bronchitis high concentrations of oxygen are produced by the concentrator. We have shown that this machine may be used in the home of a patient over several months. Nevertheless, further improvements are required in the reliability of the components and in the reduction of noise. If these problems can be overcome the domiciliary oxygen concentrator should be a realistic alternative to cylinders of oxygen.

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