The present results suggest that men in the survey with higher than average titres may have been infected through contact with the lungs, livers, hearts, and spleens of sheep, pigs, and cattle. A second possibility is that the dogs and cats became infected by ingesting the toxoplasma organisms from their food and in turn infected their owners through their faeces. *Toxocara cati* may carry toxoplasma cysts (Hutchinson, 1967), and this is a form of faecal transfer which must be considered. Few of the husbands and wives had ever treated their cats for worms, and a history of "worming" dogs had no effect on the toxoplasma dye test titres in the survey; but this, of course, does not rule the possibility out. A third alternative is that the dye test titre may rise in response to ingestion of dead toxoplasma organisms by persons infected earlier in life. The limitation of the strong correlation to the men, however, suggests a more specific response. A fourth suggestion that they could be contaminated by infected pet saliva when feeding their animals is made less likely by the results of a survey of cat and dog bites in the same practice. No rise in titre was found one month after the bite in 19 people bitten by dogs and one bitten by a cat.

When all the variables are taken into account the significant findings are the high dye test titres in both husbands and wives who owned cats and dogs at the time of the investigation, and particularly the high titres in the husbands who handled pet food in less than clean surroundings. It is suggested that the higher level of antibody in this group of men could be due to handling infected raw lungs, liver, and tissues used for pet food. The wives' higher titres appear to have been gained in a different way, and they may have been infected at earlier ages than their husbands. Further studies of different age groups would be needed to find out how and when their infections were acquired.

It is important to remark that these results relate only to a selected group of people in one particular urban area. Toxoplasma dye test titres are known to display different patterns in different areas. Nevertheless, the present method of study may prove useful in other surveys.

I should like to thank Professor E. G. Knox, of the Department of Social Medicine, University of Birmingham; Dr. W. Kwantes and the staff of the Public Health Laboratory, Swansea; Dr. K. Cross and the Royal College of General Practitioners' Records and Research Unit; and Mr. R. Crow for help in this study; also Dr. J. C. Siim, Dr. J. K. A. Beverley, and Dr. D. G. Fleck for helpful discussions.

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A 60% Oxygen Supply for Medical Use

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Summary: A supply of 60% oxygen with 40% nitrogen should be acceptable for most clinical purposes, since usually only low dosages of oxygen are required. The gas may be provided by means of an oxygen concentrator (Rimer–Birlec), which is a compact, transportable, electrically operated apparatus capable of providing 28 l./min. (1 cu. ft./min.) of 60% oxygen from a source of compressed air. The biological effect of the gas from the device is the same as that of 60% oxygen from a conventional source. Measurements of inspired oxygen concentration show that the 60% oxygen may be used with present-day oxygen masks to provide inspired oxygen concentrations in the range 25 to 40%; for higher inspired concentrations alternative equipment is likely to be required. The concentrator appears to be a practical source of oxygen for expeditions and out-of-the-way places. It may provide an economical supply for a ward block, and with further development should be a convenient source of 30% oxygen for domiciliary use.

Case for 60% Oxygen

Oxygen for use in hospitals is normally supplied as 100% "pure" gas. The majority of applications in general medicine, surgery, and paediatrics, however, are for 25 to 40% oxygen (*British Medical Journal*, 1967), while the prolonged use of concentrations in excess of 60% invariably carries an increased risk from oxygen toxicity (Welch *et al.*, 1963; Nash *et al.*, 1967). In addition, in relation to anaesthesia, as for subjects exposed to acceleration, the use of 100% oxygen may give rise to atelectasis. In the case of aviation this hazard may be overcome by the routine use of a 40 to 60% oxygen: nitrogen mixture which is switched to 100% oxygen only in the event of failure of cabin pressurization (Ernsting, 1965).

There would seem to be a strong case for a similar provision in anaesthesia. In this event the requirement for 100% oxygen is confined to a relatively small number of patients with circulatory collapse and pulmonary arteriovenous shunting, also to patients with acute carbon monoxide poisoning and others who may require hyperbaric oxygen therapy (see, for example, Cotes, 1968). Ideally, these patients should be treated in an intensive care unit where 100% oxygen would be available. The likelihood that such patients will continue to require treatment in general wards should not, however, inhibit consideration of possible local production of a 60% oxygen: nitrogen mixture by removal of nitrogen from air. For oxygen in out-of-the-way places or where there is a relatively constant demand the cost is usually less than that for an equivalent volume of oxygen supplied in the conventional manner. The equipment for production of 60% oxygen is now available commercially (Cooper, 1968).

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Assessment of Rimer-Birlec Concentrator

The Rimer-Birlec concentrator utilizes the principle of differential absorption whereby nitrogen molecules in the air are held longer than oxygen molecules on a surface of synthetic calcium aluminium silicate (molecular sieve) contained in canisters. The air is delivered from a source of compressed air and the nitrogen is removed subsequently by flushing and application of suction. By alternating between two canisters the period of oxygen enrichment in the one is made to coincide with the period of discharge of nitrogen from the other ; in this way a continuous supply of gas containing a nominal 60% oxygen is obtained. The prototype apparatus which was tested on two occasions measured 0·6 by 0·6 by 1·8 m. high (2 by 2 by 6 ft.) and was mounted on castors ; it required an electrical supply and a source of compressed air capable of delivering 0·11 cu. m./min. (4 cu. ft./min.) at a pressure of 410 kN/sq. m. (60 lb./sq. in). It included a filter for the input gas, a vacuum pump, and a gas storage reservoir (Fig. 1). The vacuum pump turned out to be noisy.

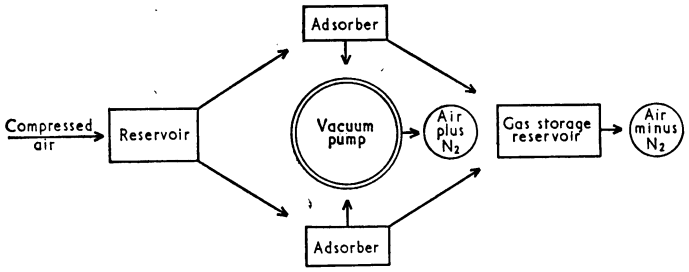

FIG. 1.—Flow diagram for oxygen concentrator. The compressed air and the suction alternate between the two adsorption chambers so that the one is acting as a sieve for nitrogen while the other is being emptied of the nitrogen which it retained during the previous compression. The cycle of operation takes three minutes.

In the first trial over periods up to 39 hours the apparatus was found capable of producing 28 l./min. (1 cu. ft./min.) of about 50% oxygen. The concentration was independent of the rate of withdrawal from the apparatus ; it varied from 56% (range 51–60%) about 20 minutes after the apparatus was switched on from cold to 51% (range 47–55%) after about three hours. At all times a concentration of 50% could be secured by suitable operation of the controls.

In the second trial, after adjustment of the mechanism, a plateau concentration of 60% at a pressure of 410 kN/sq. m. (60 lb./sq. in.) was attained regularly (Fig. 2). The power consumption was about 3 kw., giving a running cost of about 6d. per 3·4 cu. m. (120 cu. ft.) of gas produced. For an apparatus delivering about 30% oxygen the vacuum pump would not be necessary, hence the cost, also the size and the amount of noise, would be materially less. The molecular sieve material was found to retain its properties during the trials, which extended intermittently over three years.

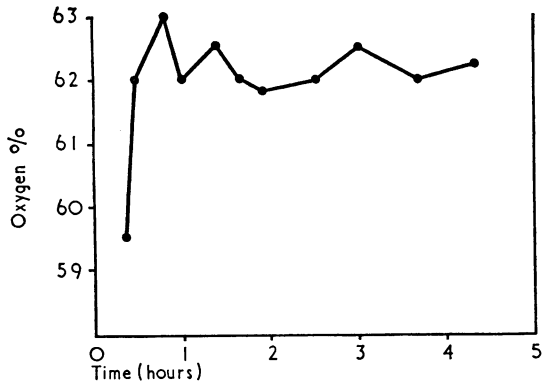

FIG. 2.—Output of Rimer-Birlec oxygen concentrator.

The apparatus was assembled from standard components, all of which had been tested by use in compressors and other commercial equipment ; it appeared to be rugged and we found it reliable. Some adjustment of the controls, however, was necessary in order to maintain a specified oxygen concentration ; arrangements are now being made for the concentration to be monitored continuously by a Servomex oxygen analyser and for the controls to be reset automatically to maintain the concentration of oxygen which is required. No failure of components occurred during the trial, but should this happen the equipment would "fail safe" with the storage reservoir full of respirable gas. A continuous supply could then be assured by arranging for a second apparatus to take over in the event of a fall in pressure in the reservoir.

Inhalation of Oxygen from Concentrator

On account of noise from the vacuum pump it was not found practical to put the concentrator in a ward. Instead the equipment was set up in a laboratory, where the gas was breathed by normal subjects and patients at rest on a number of occasions for up to two hours at a time. The exercise ventilation (also respiratory and cardiac frequency) of a patient breathing 60% oxygen from the concentrator was identical with that when breathing the same concentration prepared by dilution of 100% cylinder-oxygen with air (Fig. 3). Thus in this instance the concentrator-oxygen was biologically equivalent to cylinder-oxygen of the same concentration. The gas contains rather more of the rare gases than does air, since these are concentrated along with the oxygen and not removed with the nitrogen. In addition, in the event of air from a polluted atmosphere being fed into the equipment the possibility arises of contamination with sulphur dioxide, ozone, or other substances. Thus consideration should be given to the location of the air intake and also to the provision of appropriate filters.

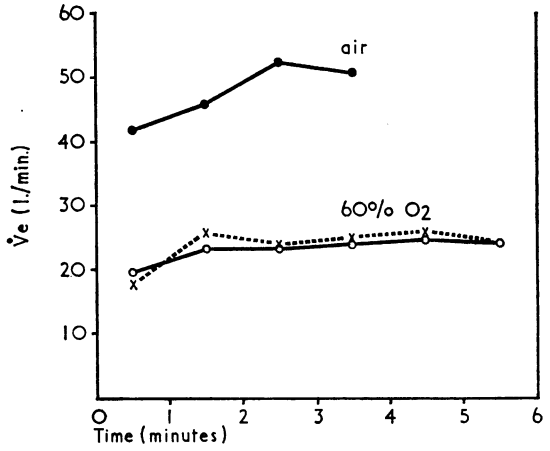

FIG. 3.—Exercise ventilation of a patient with chronic lung disease breathing 60% oxygen from the concentrator (× - - - - ×) and from a cylinder (O——O) compared with breathing air.

60% Oxygen with Conventional Oxygen Masks

Experience with oxygen masks and related devices is so far mainly based on 100% oxygen. The devices may also be used with 60% oxygen at a higher flow rate, but it is to be expected that some will be found more effective than others. Thus a mask containing a Venturi device which entrains a predetermined proportion of air may be expected to do this irrespective of the concentration of oxygen in the delivered gas. By contrast, nasal cannuli coupled to a Woulfe bottle tend to cause crusting in the nose when used with more than 4 l./min. of 100% oxygen ; the cannuli are therefore unlikely to be suit-

able for 60% oxygen if, as seems probable, higher flow rates are then required.

In order to obtain more information we have measured the respired oxygen concentration during breathing through some devices for administering oxygen which are in current use (Cotes, 1968). The subjects were three normal adults from the staff of the laboratory; they were studied under quiet resting conditions in an upright seated posture. Measurements were made during the last minute of consecutive periods of three to five minutes with the different masks and flow rates. The respired gas was sampled in the nasopharynx at a flow rate of 14 ml./min. via a polyethylene catheter (diameter 0·7 mm). This became blocked during some experiments, and the results to be reported are based on three or four sets of data for each device where the tube remained patent throughout.

The gas was analysed for oxygen and carbon dioxide with a respiratory mass spectrometer (Associated Electrical Industries Ltd., MS 4) coupled to a four-channel recorder (Sanborn). The linearity and stability of the calibration were established by means of a Wösthoff pump (Cotes, 1968). The record of concentration of carbon dioxide was used to determine the phase of respiration. The average inspired oxygen concentration was taken as the mean of the maximum and minimum values recorded during inspiration; the end-tidal concentration was taken at the end of expiration. The record of concentration was found to be of variable pattern as between the several devices, though for any one of them it was reasonably consistent. Thus, in the absence of measurements of ventilation, comparisons of inspired oxygen concentration for different doses of oxygen via the same devices were likely to be more meaningful than comparisons of one device with another. We therefore used as an index the flow rate (up to 6 l./min.) of 60% oxygen which was required to match the oxygen concentration provided by 2 l./min. of 100% oxygen; we have called this quantity the matching flow rate. The findings are listed in Table I, with the exception of those for the Portogen mask, where the results were similar to those for the Porton mask, and the nasal cannuli, where the required flow rates of 60% oxygen exceeded the maximum acceptable rate of 4 l./min.

TABLE I.—*Observed and Predicted Flow Rate in l./min. of 60% Oxygen to Match the Inspired and End-tidal Concentrations Obtained with 2 l./min. of 100% Oxygen**

Mask	Data for Inspired Gas			Data for End-tidal Gas	
	Observed	Range	Predicted	Observed	Range
Edinburgh ..	4·0	3·0–5·0	4·0	4·0	3·3–5·0
M.C.	5·0	4·5–5·3	5·1	4·5	4·0–5·0
Polymask ..	5·3	4·5–6·5	3·2	5·4	3·8–6·0
Porton	>6·0	5·0 upwards	3·6	>6·0	5·3 upwards
Ventimask (35%)	4·0	4·0 throughout	4·0	4·0	3·0–5·0

* Or in the case of the Ventimask to match the 28% oxygen version (entrainment ratio 9 : 1).

In each experiment we obtained two separate estimates of the matching flow rate respectively from the inspired and the end-tidal oxygen concentrations; the flow rates turned out to be very similar. As a further check on the reliability of the data we compared the average observed inspired and end-tidal oxygen concentrations for each device during breathing 2 l./min. of 100% oxygen (Table II) with those reported in the literature (Green, 1967; Cotes, 1968); with the exception of the inspired concentration for the Polymask they also turned out to be similar (Table I). There are no comparable data for 60% oxygen, so we calculated expected values for the inspired oxygen concentration and hence for the matching flow rate.

TABLE II.—*Inspired and End-tidal Gas Concentrations During Breathing 2 l./min. of 100% Oxygen*

Mask	Inspired Gas. O_2 Concentration (%)			End-tidal Gas			
				O_2 Concentration (%)		CO_2 Concentration (%)	
	Mean	Range	Predicted	Mean	Range	Mean	Range
Edinburgh	28	27–36	28	21	20–22	5·6	4·4–6·2
M.C. ..	37	33–43	35	30	28–32	6·0	5·5–6·6
Polymask	34	30–42	39	31	26–39	5·9	5·3–6·8
Porton ..	41	36–46	39	35	32–38	5·9	4·7–6·6
Ventimask (28%) ..	28	26–29	28	22	20–24	5·6	4·9–6·2

For the calculations we assumed a minute ventilation of 7·5 l./min. and used the average observed respiratory frequency. We also assumed complete mixing within the dead-space of the mask, which was taken to be for the Polymask 300 ml., for the M.C. mask 90 ml., and for the Porton and Portogen masks 50 ml. A zero dead-space was assumed for the Edinburgh mask and nasal cannuli. The validity of the calculation was assessed by applying it to predict the inspired oxygen concentration during breathing 2 l./min. of 100% oxygen. The prediction was made with acceptable accuracy (Table II). Similar accuracy of prediction for 60% oxygen would be evidence that the masks are as effective with 60% as they are with 100% oxygen. This turns out to be the case for the Ventimask and the Edinburgh mask, where there is no rebreathing or storage of oxygen during expiration, and for the M.C. mask, where the degree of rebreathing or storage is small; but for the Polymask, to a small extent, and for the Porton mask, to a much greater extent, the flow rate of 60% oxygen, which matches the effect of 2 l./min. of 100% oxygen, is in excess of that predicted.

Discussion

The data, on account of their internal consistency and, for 100% oxygen, agreement with published results, appear to be reliable despite their being based on study of only three subjects. In addition, for the masks where there is little storage of oxygen during expiration the results are supported by an arithmetic analysis based on a simple model which also predicts reasonably accurately the inspired oxygen concentrations with 100% oxygen. The concordance of these two approaches suggests that where a low dosage of oxygen (25 to 30%) is required, as for the treatment of a patient with respiratory insufficiency, this may be provided by using a source of 60% oxygen and the Edinburgh mask, or appropriate Ventimask. For an inspired concentration of 35 to 40% a Polymask or M.C. mask may similarly be used. Sixty per cent. oxygen then has an advantage compared with 100% oxygen that, on account of the higher gas flow rate, the accumulation of carbon dioxide in the facepiece is materially reduced. The optimum therapeutic flow rate, as for other forms of oxygen therapy, should be determined by the response of the patient; for the dosages and masks which are listed above an initial flow rate of 4 or 5 l./min. would seem appropriate. Inspired oxygen concentrations in excess of 40% cannot be provided economically when using 60% oxygen with the devices tested, but they may be attainable in other ways.

A change in the method of dispensing oxygen requires careful assessment, especially when the main justification is on economic rather than on medical grounds. Validation is likely to come first in circumstances where the present cost is high—for example, hospitals and aid posts in out-of-the-way places and, on a smaller scale, vehicles and possibly domiciliary use (*Lancet*, 1969), where only low concentrations of oxygen are normally required. In view of the increasing cost of medical oxygen, however, there is a case for assessing the relative advantages and disadvantages of a dual supply of 60 and 100% oxygen for a block of wards compared with a conventional arrangement.

We are indebted to Mr. A. G. Cooper, of Rimer Manufacturing Co. Ltd., Melingriffith Works, Whitchurch, Cardiff, for bringing this device to our attention; to Mr. I. J. Morris, assistant chief engineer to the Welsh Board of Health, for his appraisal of the overall costs; and to both Dr. J. N. Lunn, senior lecturer in anaesthetics at the Welsh National School of Medicine, and our

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Platelet Life-span and Sites of Platelet Sequestration in Onyalai*

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Summary: With radioactive chromium, platelet kinetic studies were carried out in four patients with onyalai, a form of thrombocytopenic purpura occurring in the African Negro. Results were compared with those of White patients suffering from idiopathic thrombocytopenic purpura. In the onyalai patients platelet life-span was considerably reduced, and this was associated with a definite rise in radioactivity over the spleen in three of the four cases. In two patients remission was associated with steroid therapy, while in the other two remission followed splenectomy after steroids had failed to raise the platelet count. These findings are similar to those in White patients with idiopathic thrombocytopenic purpura.

Introduction

Onyalai is a Bantu name for a bleeding disease characterized by the presence of blood blisters in the mouth (Wellman, 1904). The condition, which is widespread in the Bantu throughout Africa south of the Sahara, is a form of thrombocytopenic purpura (Blackie, 1937) in which megakaryocytes are present in the bone marrow in normal or increased numbers (Gear, 1938; Lewis and Lurie, 1953). Most cases run an acute course indistinguishable from acute idiopathic thrombocytopenic purpura in Whites (Metz *et al.*, 1958). The relation between onyalai and other forms of idiopathic thrombocytopenic purpura is debatable. The introduction of radioisotopic methods of measuring platelet life-span and determining the sites of platelet sequestration has enabled idiopathic thrombocytopenic purpura to be classed as a form of thrombocytopenia resulting from increased peripheral destruction of platelets (Hirsch and Gardner, 1952). As the mechanism of the thrombocytopenia in onyalai is unknown, platelet life-span and sites of platelet destruction were studied in Bantu patients with onyalai, and the results compared with those of White patients with idiopathic thrombocytopenic purpura. Considerable shortening of platelet life-span was found in all the onyalai patients, but there was no consistent pattern of surface radioactivity.

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Material

Seven patients were studied. Four were typical cases of onyalai—that is, Bantu with haemorrhagic bullae in the mouth, thrombocytopenic purpura, and a normal or an increased number of megakaryocytes in the marrow. The relevant clinical and haematological data are summarized in Table I. The other three were white patients with acute thrombocytopenic purpura associated with normal or increased number of megakaryocytes in the marrow. No lupus erythematosus cells were detected in any of the patients studied.

Methods

Platelet survival was measured with radiochromium (^{51}Cr) as described by Harker (1968). Autologous or ABO compatible blood was drawn into a Fenwall triple bag plasmapheresis set containing ACD (citric acid, trisodium citrate, and dextrose) solution, in a ratio of 7 to 1. The triple bag was centrifuged at 300 *g.* for 12 minutes, the platelet-rich plasma being transferred into a satellite bag. The red cells were reinfused into the donor. When necessary the *p*H of the platelet-rich plasma was adjusted to 6·5 with 0·15 M citric acid. The platelet-rich plasma was centrifuged at 1,000 *g.* for 16 minutes and most of the supernatant platelet-poor plasma transferred into the second satellite bag. The platelet button was resuspended in about 20 ml. of remaining plasma. Then 250 μCi of sodium chromate (^{51}Cr) solution *B.P.* (specific activity 50–150 mv./mg.), obtained from the Radiochemical Centre, Amersham, U.K., was added to the platelet suspension and incubated for 15 minutes. The labelled platelets were washed twice in platelet-poor plasma from the second satellite bag and then resuspended in from 15 to 20 ml. of plasma. An aliquot was removed for the preparation of a standard. All these manipulations were performed at room temperature and under sterile conditions.

The ^{51}Cr-tagged platelets (in about 20 ml. of plasma) were injected intravenously into the recipients, following which venous blood samples (10 ml.) were drawn into 0·2 ml. of 10% potassium edetic acid at 10-minute intervals for the first half-hour and then half-hourly for the next three hours, for the first day. Subsequently blood samples were drawn daily until the platelet radioactivity was less than 10% of the peak value. After the addition of 5 ml. of saline the blood samples were centrifuged at 300 *g.* for seven minutes and the platelet-rich plasma was removed. This procedure was repeated, and the platelet suspensions were pooled. The pooled platelet-rich plasma was then centrifuged at 1,500 *g.* for 20 minutes, the super-