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An Oxygen Chair

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Hypoxia plays an important role in the cause of death of infants who die of acute lower respiratory tract infections (Morrison, 1955; Disney *et al.*, 1960). Heycock and Noble (1956) found the highest mortality (8% of 108 babies) was in the 6-months or under age-group, and they attributed this to hypoxia. It is for this group that our apparatus is specifically designed†. Flenley (1967) has suggested that the tension of the inspired oxygen must be such that the partial pressure of oxygen at mitochondrial level is at least 10 mm. Hg. Since often the disease resulting in this disturbance of blood gases is viral in origin (Holzel *et al.*, 1963; Elderkin *et al.*, 1965), oxygen is the mainstay of therapy, antibiotics playing only a minor role (Davis and Wedgwood, 1965). Morrison (1955), Heycock and Noble (1956), and Disney *et al.* (1960) all found that high concentrations of oxygen were required for the satisfactory management of these cases.

Lower respiratory tract infection is the greatest single cause of death in children from the end of the first month to the end of the first year. Though antibiotics have reduced the number of deaths from respiratory tract infection, infants have benefited less than older children. This is associated with the more important role of viruses as infecting agents in this age-group. Bacterial infection was responsible for only 6 of the 22 deaths in infants and young children in Newcastle (Gardner *et al.*, 1967). Elderkin *et al.* (1965) isolated viruses in 31% of cases of bronchiolitis and 33% of cases with pneumonia. When they took a rising titre of antibodies into account, then viral infections accounted for 62% of the cases of bronchiolitis and 42% of those with pneumonia.

The need for improved oxygenation in these babies is vital. Morrison (1955) showed that oxygen tents, as commonly employed, did not achieve a sufficiently high oxygen concentration. Simpson and Flenley (1967) confirmed that the administration of 40% oxygen cannot be relied upon to produce a normal arterial Po_2.

Currently available tents used in the administration of oxygen in paediatric practice fall short of the ideal in the following ways. High concentrations of oxygen cannot be achieved in most tents. In those in which levels of over 60% can be achieved, the oxygen required, as measured by the flow rate in litres per minute, is uneconomic (i.e. 20 litres per minute). In addition, a considerable period is necessary before these concentrations are achieved. In those tents measured by us the maximum concentration could not be achieved in under 30 minutes, with an oxygen flow rate of 20 litres per minute. Examination of the child, changing the baby's nappies, or even feeding, interferes with the oxygen concentration inside the tent; which falls abruptly when only one zip is opened during feeding or when carrying out other procedures (Simpson and Russell, 1967). Consequently, an accurate trend of arterial Po_2 cannot be established as a guide to therapy, since blood gas measurements cannot be obtained under standard conditions.

Though satisfactory humidification of up to 90–95% relative humidity (RH) may be achieved in an oxygen tent, the cooling systems employed result in this humidity being achieved at low temperatures. When gases in this environment are inspired, they are warmed to near body temperature at the expense of a marked drop in RH. In view of the tachypnoea associated with these illnesses, it is important to maintain a high RH in the respiratory tract if water loss and electrolyte imbalance are to be avoided. That this water loss may pass unnoticed is alluded to by Harrison and Finberg (1959), who state that a water loss equivalent to 10-15% of body weight can occur in this way without clinical signs of dehydration: this water loss leads to hypernatraemia, which may be a cause of hyperpyrexia.

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†A patent is pending for this apparatus.

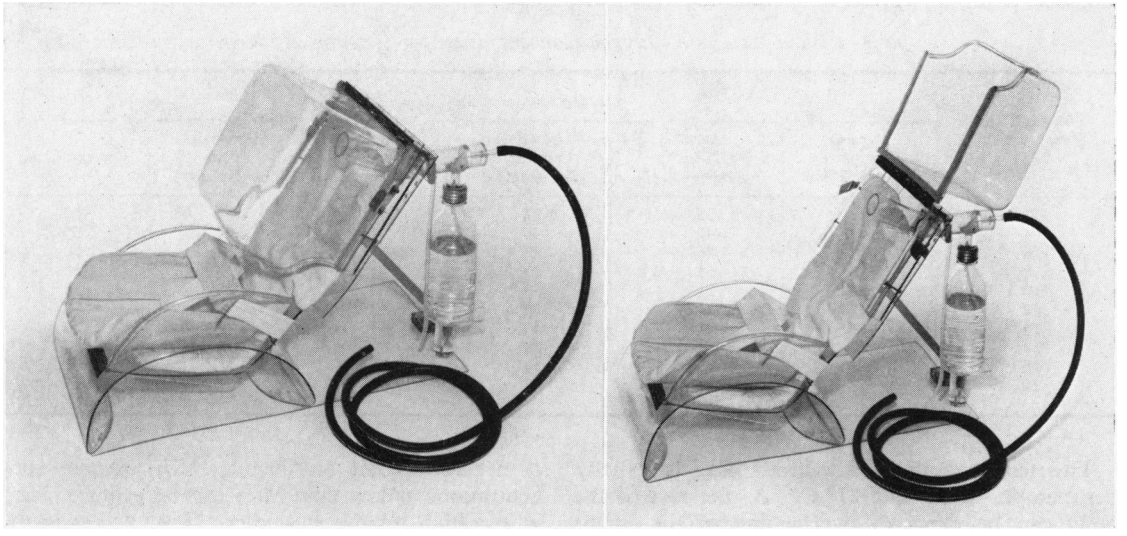

FIG. 1.—*The chair* (a) *with hood closed* (b) *with hood open.*

Apparatus

The apparatus described here is capable of administering high concentrations of oxygen at RH 90–95%. The chair has been designed particularly for infants with lower respiratory tract infection, or with cardiac failure secondary to pulmonary disease or to congenital heart abnormalities.

It comprises a wide-angle seat (120°) on a semicircular support which is fixed to a flat base 30 × 60 cm. (1 × 2 ft.). The seat is tilted backwards 10° from the horizontal base, and the baby is held in the seat by a waist and crotch strap. These are made of 2·5 cm. (1 in.) wide webbing and are held together by Velcro fastening. The wide angle of the seat and the 10° backward tilt seat the baby in such a way that the legs do not interfere with abdominal movements. This feature is considered important as babies rely a great deal on diaphragmatic breathing. Since their respiratory reserve is low, it is important to nurse them in a position optimal for such breathing.

The head and shoulders of the infant are covered by a transparent plastic head piece 24 cm. long by 24 cm. wide by 19 cm. deep, which is hinged at the upper end of the chair. It can be raised, either to put the infant in the chair, or if naso-pharyngeal aspiration is required.

The inlet of the head piece is contoured to the curve of the baby's chest and shoulders and, at its highest point, is 15 cm. from the back of the chair. This allows a space between the baby's chest and the head piece of about 2·5 cm. in the case of small infants and about 1·25 cm. in the case of big babies.

The chair has been constructed in the hospital workshop from sheeting 25 mm. (0·1 in.) thick. It weighs only 3½ kg. and can be easily fitted into a small cot.

A low flow rate nebulizer is incorporated and this is connected to the back of the chair by 3·8 cm. Perspex tubing. The chair is illustrated in Fig. 1a and Fig. 1b.

Discussion

The oxygen concentrations achieved at given oxygen flow rates are higher than in tents currently available. The Table shows oxygen concentrations, measured with a Beckman Paramagnetic Oxygen Analyser, in a number of tents as used in routine practice in the ways specified by the manufacturers. Multiple readings were made at each flow until a constant reading was obtained.

Using this chair, it was found that oxygen concentrations up to 80% were achieved within five minutes of turning on the oxygen at the required flow rate. The flow rates required to provide a given oxygen concentration are shown in Fig. 2.

Examination of the infant may be carried out without interfering with the level of oxygen inspired (Fig. 3). It is found possible even to change the infant's nappies, to tube feed, to carry out ECGs, or to obtain brachial artery samples while the infant's head remains within the head piece. CO_2 build-up within the hood is not a problem as this is washed out by the inflowing oxygen, as was shown by the fact that no rise in arterial P_{CO_2} was recorded in children maintained on flows of 1–2 l./min. during the recovery phase of their illness.

TABLE

Oxygen Flow Rate and Oxygen Concentration for Various Apparatus

Oxygen Flow Rate (l./min.)	Oxygen Concentration in Apparatus					
	Type D Croupette (Air Shields)	Mark V Tent (Oxygenaire)	Universal Croupette (Air Shields)	Universal Tent (Oxygenaire)	Humidaire Tent (Oxygenaire)	Oxygen Chair
2	35	35	23	38	40	40
4	43	42	25	41	45	50
6	48	46	28	42	52	60
8	52	51	29	43	58	65
10	52	51	30	43	64	70
12	52	51	30	43	70	74
14	52	51	30	43	73	74
16	52	51	30	44	74	80
18	52	51	30	44	75	81
20	52	51	30	44	75	81

The temperature in the head piece is usually between 25·5° C. and 27° C. As the rest of the body can be exposed, overheating of the infant is never a problem. Since an RH of 90–95% is achieved in the head piece at a higher temperature than in tents, there is less fall in RH when these gases are inspired and are warmed to near body temperature.

Summary

An apparatus is described which allows infants to be nursed at high oxygen tensions. It consists of a plastic chair and hood. High oxygen concentrations at low flow rates can be achieved, and with a high relative humidity. Easy access to the patient is available without altering the oxygen concentration inspired.

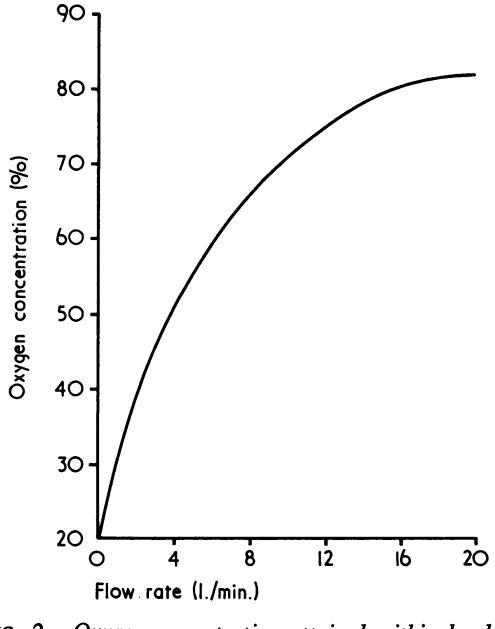

FIG. 2.—*Oxygen concentration attained within hood at different flow rates.*

FIG. 3.—*Examination of the baby, or changing its napkin, can be carried out without interfering with the baby's oxygen environment.*

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