CONTROL OF THE CONCENTRATION OF OXYGEN IN TENTS FOR PREMATURE BABIES

BY

A. L. GUNN, M.D., B.Sc., F.R.C.S.Ed., F.R.C.O.G.

W. K. SUTTON, M.R.C.S., L.R.C.P.

AND

M. ULUSOY, M.D.

(From the Maternity Department, Lewisham Hospital,
London)

Oxygen tents are in general use in hospitals to treat premature or sick babies. It has been feared that too high a concentration of oxygen may be harmful (Smith, 1950), and various writers have considered whether retrolental fibroplasia, which causes much blindness among smaller premature babies, has not been brought about by giving them too high concentrations of oxygen (Minton and Cole, 1951; Bembridge *et al.*, 1952). Szewczyk (1951) suggests that it is the sudden diminution of oxygen concentration which occurs when a baby is removed from an atmosphere of 60% to 70% oxygen which induces the disease.

Obstetricians and paediatricians alike have been anxious not only because they do not know the cause of retrolental fibroplasia but also because in most cases they do not know the oxygen concentration to which the babies have been exposed. It was usual to regulate the standard Queen Charlotte oxygen tent flow-meter to 2 or 3 litres a minute; but recently this has been commonly reduced to 1.5 litres a minute. Jackson (1951) has shown that the same type of tent can attain an oxygen concentration of 70% with a flow-meter reading of only 1 litre of oxygen a minute.

Our tests with the tents in everyday use in the nurseries of our maternity department have shown that with the flow-meters registering from 1 to 2 litres of oxygen a minute the oxygen concentration may be as low as 30% or as high as 80%. The object of this paper is to describe a simple method of obtaining the desired concentration with certainty.

Causes of Variations

There are without doubt great differences in the leakage rates of tents. Some tents have a port 1.5 cm. in diameter with a sliding metal cover. The hinged lid fits tightly on to sorbo seating, which is air-tight. In an old tent these parts may give rise to leakage, and small defects may appear near the hinges of the lid.

The manner in which the cot and its tent are made up must affect the oxygen-leakage rate from the tent. Also, the oxygen concentrations will be unpredictable if the flow-meter does not give an accurate reading. The flow-meters supplied with the tents have a small scale registering a maximum of 11 litres a minute, so that when the lower end of the scale, about 1 or 2 litres a minute, is chiefly used it would be surprising if the meters were uniformly accurate. The larger the baby in the tent the greater will be the loss of oxygen due to respiration.

Apparatus and Methods Used

The Queen Charlotte tent consists of an oval bottomless box of transparent plastic mounted on a metal frame with vertical sides. The top of the box is in the form of a

hinged lid. Oxygen is supplied through a metal tube connected through rubber tubing by way of a flow-meter to a standard oxygen cylinder. The B.O.C. oxygen analyser was used to read off the oxygen concentrations in the tents. This interesting instrument gives an instantaneous reading on a scale. It operates on the Pauling principle, which depends on the magnetic properties of oxygen.

Each sample for analysis was taken by a rubber tube passed through the port, or an aperture specially made, to a point in the centre of the tent well away from the oxygen supply tube. The oxygen analyser was kindly lent by the research and development department of the British Oxygen Company Ltd., whose scientific staff assisted throughout. Many readings were taken of various tents, and the following results are given as typical.

Tent A was set up in working conditions resting direct on the cot mattress with only a rubber sheet and a single thickness of cotton sheet intervening. It contained a healthy baby weighing 6 lb. 2 oz. (2.8 kg.). The oxygen concentra-

Fig. 1.—Oxygen concentrations produced in tent A, containing baby weighing 6 lb. 2 oz. (2.8 kg.). Curves V-Z= oxygen flow-meter readings of 1-5 litres a minute respectively.

tion was recorded every two minutes with the flow-meter reading 1 litre a minute, and the results were plotted as a curve V in Fig. 1. This was repeated with the flow-meter reading first 2 litres and then 3 litres a minute to give curves W and X in Fig. 1. The same tent A was set up next day under apparently similar conditions and curves Y and Z were plotted for a flow of 4 and 5 litres of oxygen a minute respectively.

It will be noted that each curve rises steeply until it reaches a plateau in 45 minutes, after which the concentration of oxygen increases by only unit percentages and certainly by less than 10%. The form of this curve is so consistent that it can be accepted that a single estimation of the oxygen concentration in the tent, which has been kept closed for 45 minutes with the oxygen flowing at a uniform rate, will give a *calibrating* oxygen percentage for that reading on the flow-meter. Thus if we wished to give a baby 40% oxygen, and after 45 minutes with the flow-meter at 1 litre a minute the reading was 35%, we should know that a proportionate increase in the flow was necessary. A further reading within the ensuing 45 minutes would then show the result of the adjustment.

Comparison of 10 Tents

Nine other tents, B to K, were then tested under similar working conditions to those used for tent A and using various rates of oxygen flow from 1 to 5 litres. Some tents

FIG. 2.—Comparison of the varying concentrations of oxygen produced, showing no reliable relation to the recorded flow of oxygen. Columns represent concentrations of oxygen produced after 45 minutes' constant flow in 10 different tents A-K. The flow-meter reading in litres a minute is given at the top of each column.

contained a baby and others did not. Curves of similar form were obtained, reaching a constant concentration after about 45 minutes, but the concentration of oxygen was not by any means proportional to the flow of oxygen recorded on the flow-meter.

Fig. 2 shows the concentrations of oxygen reached after 45 minutes' constant flow in the 10 tents. It will be seen that, working at 2 litres a minute with a baby inside, tent G reached to a concentration of 81%, tent J 56%, tent B 48%, and tent A only 38% oxygen. In other words, the oxygen concentration in the various tents does not have a constant relationship to its flow-meter reading. The concentration can be ascertained only by analysis, and the simple way is to take a single calibrating test 45 minutes after the tent has been closed and the flow-meter set. Further analysis will be necessary whenever there is any doubt or if the working conditions are changed.

Flushing the Tent

The next investigation carried out was to find whether it is possible to shorten the 45 minutes' running which is required for the oxygen content of the tent to become constant. It was found that, by running the flow-meter at three times the intended rate for the first five minutes after the tent is closed and then reducing the flow to normal, the constant concentration of the oxygen is reached in 30 minutes. Fig. 3 shows the effect of this five minutes' flushing at treble flow. The five minutes must be accurately timed, because at this rate of flow very high concentrations could be reached.

The single tests can be carried out quickly by the pyrogallol method, and our pharmacists have devised a simple method of doing this which they describe at page 1340 of this issue.

FIG. 3.—Concentrations of oxygen obtained, showing effect of flushing with triple flow (interrupted lines) during the first five minutes.

Conclusions

Nurses make up tents in different ways, flow-meters are variable, babies are of different sizes, and tents do not leak equally; therefore, whenever a tent is set up there is a new and unpredictable arrangement requiring a calibration of its own.

Calibration is done by taking a single oxygen analysis of the tent after it has been working with a constant flow for 45 minutes.

To shorten this calibration time the tent may be flushed with three times the chosen flow for five minutes, and then the analysis of the oxygen should be made after the flow has been normal for a further 25 minutes.

We are grateful to Dr. A. Bracken and his staff of the British Oxygen Company Ltd. for considerable help.

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The medical officer of health and port medical officer of Plymouth, Dr. T. Peirson, describes methods for the purification of oysters in a recent article in *The Medical Officer* (November 1). About 50 years ago several outbreaks of typhoid fever were traced to the consumption of sewage-contaminated shellfish, and public confidence in the safety of oysters, mussels, and cockles was severely shaken. Confidence, in Dr. Peirson's words, "has not yet recovered. Sewage-polluted shellfish are a very real source of danger to the public health." Nowadays local authorities have powers to close oyster beds which are likely to endanger the public health, and, as an additional safeguard, the Fishmongers' Company carries out careful and systematic bacteriological sampling of shellfish coming to the markets in the City of London. Sometimes a local authority will permit the sale of shellfish from a polluted laying if first the oysters are cleansed at an approved establishment. The usual method of purification is as follows: first, external mud is removed by hosing; then the oysters are bathed twice in purified sea-water, subjected to further hosing, and their dejecta drained off; then they are placed for a short period in chlorinated sea-water to sterilize the outside of the shells; and finally they are packed in containers which themselves have been sterilized with chlorine.