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OXYGEN TENTS AND NASAL CATHETERS*

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The principle of the Guy's oxygen tent is that the mechanism for cooling and drying the air is in the tent itself, so that the only function of the ventilating air current is to circulate the air and remove carbon dioxide. A relatively small flow, such as is provided by the injector, is enough for this. The working of the tent has been fully described,¹ but certain modifications have since been introduced.

Modifications in the Tent

Previously the cooling mechanism consisted of two ice tins let in through the roof of the tent, with a total surface area for cooling of 1,110 square inches. These have now been replaced by a single tin with a cooling surface of 1,380 square inches, let into the tent at the side and carried on a stand, which supports the tent; the roof of the latter is now quite light. The tent can be raised or lowered on the stand, and when not in use folds up against it. The arrangement is compact.

A tray is fitted to the stand to carry the analysis apparatus and the tin of soda lime, "protosorb" brand. Bands can be fitted to the two up-rights to support two 100 cubic foot cylinders of oxygen, which rest on the floor and keep the tent in position. These must be removed if the tent is to be moved about, but not if only small adjustments of position are required. The tent can be lowered over the patient or withdrawn with the stand in position at the bedside. With two cylinders in position there is always a spare, which can be attached to the system immediately. In the tents supplied by the British Red Cross Society to the twelve voluntary teaching hospitals in London these bands were not fitted, owing to an error, so that a special cylinder stand to hold the two oxygen cylinders had to be devised.

From motives of economy only one injector is supplied with each tent, and though a full description of the mechanism has been published¹ repairs may entail some delay. There is the possibility of its failing at some awkward time when help is not available, such as in the middle of the night; if the tent had to be removed the patient might die. Consequently an attempt has been made to find a temporary substitute. Since the conditioning of the air is independent of the injector, oxygen can be passed directly into the tent through one of the sleeves, and so it is only necessary to remove the carbon dioxide.

The following experiment shows that a tray of soda lime may be introduced into the tent in an emergency. A subject remained in the tent eighty minutes without soda lime in the circuit. The proportion of CO₂ rose to between 2 and 3 per cent. A tray 14 by 19 inches covered with soda lime was then introduced, and the carbon dioxide at once fell to between 1 and 2 per cent., at which level it remained till the tent was removed two hours and twenty minutes later.

In the original model the tent was short, and tied round the patient's wrist. Since the patient often objected the tent was made long enough to enclose the whole body. It was made airtight by two sets of "Zip" fasteners on the top of the tent pulling together two cylindrical lengths of rubber. The mechanism was unwieldy and the patient had to be lifted into the tent.

The New Model

In the course of manufacture by Messrs. Siebe Gorman and Co. the present plan was evolved. The tent is made in one piece. It is spread like an apron over the bed above the patient, and tucked in under the mattress all round. The mattress is previously covered with a waterproof sheet, 9 feet by 6 feet, the waterproof surface

* A medical lecture given at King's College Hospital on January 24th.

being upwards, and it is tucked in all round under the mattress. Airtightness is secured by the two waterproof surfaces being in contact and pressed together under the mattress. The patient lies between two layers of mackintosh, separated, of course, from them by sheets and blankets. (See figure.)

Access to the patient for washing the lower part of the body, for dressings where necessary, and for bed-pans, is obtained by partially untucking the tent. Food and drink are handed in as heretofore through the sleeves, which are also used for washing the upper parts of the body. An alternative plan is to lay a mackintosh sheet under the mattress. But in this case the bed must be made up before the patient is placed on it. With the first arrangement there is less disturbance of the patient, since it is only necessary to draw the mackintosh sheeting from the foot of the bed up under him—a simple matter for two skilled nurses. The rest of the tent is then applied without moving him at all. Two inexpensive soda lime tins are supplied with the tent; these can be renewed when worn out; rusting is prevented if they are always kept closed, even when empty.

The Importance of Airtightness

The percentage of oxygen in the tent depends on its airtightness. If this is satisfactory some inflation of the tent should be noticed when oxygen is delivered for a minute or two through the by-pass at the beginning of treatment. The importance of the under mackintosh is illustrated by some experiments with the Heidbrink tent—an American tent of which some examples are available in this country. With this tent there are instructions that the best results are obtained when the mattress is covered with a mackintosh, but no special mackintosh was originally provided with the tent, though I believe this defect is now remedied, and no analysis of the oxygen content of the air is made—at any rate in this country.

The following results for the oxygen percentage were obtained with the Heidbrink tent in use at a London hospital for surgical cases where a good deal of nursing was required. With a 5½-litre flow of oxygen the percentage in the tent was 30. In another case with an 8-litre flow the maximum percentage was 35; determinations at other times gave only 25 per cent. of oxygen: the oxygen in the atmosphere is 21 per cent. Clearly the tent was doing very little good. At the same time the original Guy's model was giving consistently high figures for the oxygen percentage.

Another test was carried out with the Heidbrink tent, the mattress being covered with a mackintosh sheet. The same subject had been in the latest form of Guy's tent previously. The comparative results are shown in Table I. It required 8 litres of oxygen to raise the oxygen percentage up to 45, and with 3 litres it fell to 30.

TABLE I
Guy's Model

Time	Percentage of Oxygen	Temperature	Relative Humidity per cent.	Rate of Flow of Oxygen
1.55 a.m.	30	57°	75	2.75 litres (min.)
12.35 p.m.	40			"
1.10 p.m.		56°	69	"
2.20 p.m.	53			Rate cut down to 2.5 litres (min.)
2.40 p.m.		56.5°	72	"
3.23 p.m.	55			Rate cut down to 2.0 litres (min.)
4.10 p.m.		59°	73.5	"
4.15 p.m.	51			"

Lunch given at 1.10 p.m.; tea given at 3.50 p.m.

Heidbrink Tent

Time	Percentage of Oxygen	Temperature	Relative Humidity per cent.	Rate of Flow of Oxygen		
				Injector	By-pass	Total
11.25 a.m.	22	56°		4 litres (min.)	4 litres (min.)	8 litres (min.)
11.45 a.m.	27			"	"	"
12.20 p.m.	32	64°	73	"	"	"
12.40 p.m.	38			"	"	"
1.0 p.m.	38	62°	73	"	"	"
1.40 p.m.	40	65°	64	"	"	"
2.10 p.m.				" Rate cut down to 3 litres (min.)	" 5 litres (min.)	" 8 litres (min.)
2.40 p.m.	45	66°	59	"	"	"
3.15 p.m.	42	65°	64	" Rate cut down to 3 litres (min.)	" 0 litres	" 3 litres (min.)
3.40 p.m.	42	65°	64	"	"	"
4.50 p.m.	30	66°	69	"	"	"

Lunch given at 12.30 p.m.

The temperature rose 10°, but the humidity was satisfactory, though it rose steadily when the rate was cut down. On the other hand, in the Guy's tent with 2 litres of oxygen the percentage remained over 50. The temperature was lower, and though the humidity was a little higher than in the Heidbrink tent it remained fairly constant.

A previous test with the Heidbrink tent and extra mackintosh showed that overheating might readily occur. Thus with a fat woman suffering from bronchitis with 6 litres of oxygen the percentage of oxygen after four hours was 65, the temperature 64°, and the relative humidity 83 per cent. On cutting the oxygen flow down to 3 litres the oxygen fell to 50 per cent., the temperature rose to 66°, the humidity was 79 per cent., and the patient complained of feeling hot. This is because cooling takes place outside the tent, and the stream of air produced by the injector may be insufficient for the purpose; a motor fan would be required as in the Barach-Thurston tent or McKesson tent. The disadvantage of a motor fan is that the mechanism is apt to go wrong at unexpected moments. I was once called to such a case, where the patient had suddenly to be taken out, but, unfortunately, it was too late to save him.

The Oxygen Tent and Nasal Catheter Compared

Various types of nasal catheter have been described, and there is no doubt that the alveolar oxygen percentage can be raised by such means. Mr. T. W. Adams and I have recently studied this subject. In the first place we looked for the most effective and comfortable type of apparatus. The single nasal catheter—Jaques No. 9—that is passed three inches up the nose is uncomfortable, but tolerable at any rate for a certain length of time. A double nasal catheter passed up each nostril—we used two No. 6 catheters—was hardly tolerated without local anaesthesia. Eventually we used the forked nasal tube, which just enters both nostrils, as described by Davies and Gilchrist.²

During these experiments the subject was sitting, and the oxygen was delivered through a flowmeter which was calibrated by a standardized water meter, delivering 15 litres at each revolution. After five minutes of quiet breathing the prepared oxygen pipette was placed with its nozzle inside the subject's mouth, and the sample was taken at the end of a deep expiration following a normal inspiration; in most experiments the mouth was closed till the sample was taken, but the effect of breathing through the mouth was also tested, so as to imitate a dyspnoeic patient.

The rate of flow, number of determinations, and the maximum range are represented in Table II.

TABLE II.—*Alveolar Oxygen at Different Rates of Flow*

Subject	Rate of Flow	No. 9 Catheter			Remarks	Forked Nasal Tube			Remarks
		No. of Tests	Maximum Percentage	Minimum Percentage		No. of Tests	Maximum Percentage	Minimum Percentage	
T. W. A.	0	9	15	12	Average 13 %				Breathing air
"	2.2	9	34	17	Mouth closed	9	25	18	With Müller valve
"	2.2	3	26	21	"	3	24	18	No " "
"	3.3	3	29	27	"	3	30	23	No " "
"	3.3				"	9	29	19	With " "
"	4.4	11	31	24	"	11	35	28	With " "
"	4.4				Mouth-breathing	6	27	23	With " "
"	4.4				Mouth closed	2	28	28	No " "
"	6.7	3	37	30	"	9	39	36	With " "
E. P. P.	4.4				"	8	36	29	With " "
"	4.4				Mouth-breathing	4	35	28	With " "
"	4.4				Mouth closed	16	35	31	No " "
"	6.7				"	8	45	38	No " "
"	6.7				Mouth-breathing	4	36	30	No " "
"	8.7				Mouth closed	8	49	48	No " "

The average alveolar oxygen at 2 to 9 litres flow given in Table III was obtained by plotting the actual flow and the average of the experimental results on squared paper. As stated by Barker, Parker, and Wassel,³ we found that the alveolar oxygen was proportional to the flow.

TABLE III.—*Alveolar Oxygen at Different Rates of Flow (Average Results. Mouth Closed)*

Rate of Flow	No. 9 Catheter		Forked Nasal Tube	
	With Müller Valve	Without Valve	With Müller Valve	Without Valve
2 litres	21.5 % (T.W.A.)	22.5 % (T.W.A.)	22.5 % (T.W.A.)	20 % (T.W.A.)
3 "	21.5 % "	27.0 % "	24.5 % "	26 % "
4 "	27.5 % "	—	32.5 % (E.P.P.)	32 % (E.P.P.)
5 "	30.0 % "	—	29.0 % (T.W.A.)	27 % (T.W.A.)
6 "	32.0 % "	—	37.0 % (E.P.P.)	36.5 % (E.P.P.)
7 "	34.5 % "	—	32.0 % (T.W.A.)	29 % (T.W.A.)
8 "			37.0 % "	39 % (E.P.P.)
9 "			38.0 % "	43 % "
				50 % "

In some experiments a Müller valve, fitted with a small rubber bag, was placed between the flowmeter and the respiratory tubes, as described by Davies and Gilchrist. Since the bag expands during expiration, when the valve tends to close, an extra volume of oxygen is delivered during inspiration, and the alveolar oxygen should be higher with the valve. On the whole, the results are a little in favour of the valve, especially at the rate of 4 litres; but the difference is hardly sufficient to warrant the addition of this extra complication. The results with the valve are much lower than those found by Davies and Gilchrist (1, p. 124).

Two objections to these results might be raised. The first is that the clinical oxygen pipette provides too rough a method to give results of any value. The consistency of the results, as shown in Table IV, is a sufficient answer to this. Drs. Marriott and Robson (who since the publication of their paper⁵ have kindly collaborated with us) have agreed that in practised hands the pipette gives

sufficiently reliable results, and that its great advantage is that a large number of determinations can be undertaken at one time. Further, the results are comparable with the analyses of the air in the tent, which in this country are usually made with the pipette; for it has been shown that in the oxygen tent the alveolar oxygen is roughly that of the atmosphere of the tent.³

The second objection is that the method of sampling is inadequate. To test this we have taken samples directly from the mouth into the burette of a Haldane apparatus and simultaneously taken air into the pipette. In most cases the CO₂ percentage of the alveolar sample was alone determined, because this value would be the criterion that air from the deep recesses of the lungs was being obtained. While breathing air, the average alveolar CO₂ for E. P. P. was 5.77 per cent. and the range 5.91 to 5.55 per cent. With oxygen, administered through the nose with the mouth closed, the results, eleven in all, were higher, as would be expected—namely, an average of 6.5 per cent. and a range of 6.9 to 6.1—so that it is clear that true alveolar air was being obtained.

Since the CO₂ of the alveolar air is always absorbed during the oxygen analysis, a deduction of 6 per cent. has been made from the corrected reading of the pipette to obtain the true oxygen reading. This, in effect, means deducting 1 per cent. from the original reading (see later). Finally, four alveolar samples were analysed for oxygen, both with the pipette and with the Haldane; the following are the percentage results respectively: 27, 28.1; 29, 27.5; 31, 51.5; 47, 45.6. The low value for the pipette—namely, 31 in the third set—may be due to the fact that it was the subject's first trial with this particular technique.

These results would suggest that the clinical oxygen pipette might be used, with an accuracy of ± 5 per cent., to test whether a patient was obtaining the full value of the nasal catheter or forked nasal tube. A little practice in breathing out deeply through the mouth would be required. One of my patients gave quite a satisfactory result. During the expiration the stream of oxygen should be interrupted, as advised by Marriott and Robson.⁵ If the tip of the pipette is partly occluded by the tongue the entry of air is prevented, and too high results will be obtained.

Single and Double Catheters

An important comparison is between the single nasal catheter and the forked nasal tube. In most cases the latter gives the best results, and so this method should displace the single catheter for clinical use, especially as it is more comfortable. There is some variation between the two subjects: thus the results for E. P. P. are higher than for T. W. A. at 4 and 6 litres. Doubtless everything depends on the exact position of the tubes, and this variability is one of the disadvantages of the method compared with the tent. In this connexion quite a disconcerting result was obtained for E. P. P. on February 26th, 1935, using the same technique with a flow of 8.7 litres, which gave previously a close range of 48 to 49 per cent. On this occasion with the mouth closed the results were 37, 33, 34, 32, 37, while the average of consistent CO₂ results was 6.6 per cent., so that true alveolar air was being analysed. There was some extra irritation of the nose on this occasion, and at one time a little bleeding. To get the best results with the forked nasal tube a clear air-way is essential, and some local anaesthetic may be desirable.

On the whole, the results with the forked nasal tube are better with mouth closed than with mouth-breathing, as shown in Table II; those for E. P. P. were usually rather higher than those published by Barker and others.³ Recently H. L. Marriott and K. Robson⁵ have published

good results, using a short double nasal catheter of soft cycle-tyre valve tubing; with the use of a local anaesthetic this has been kept in position for many days. The problem remains whether with this arrangement as good results are obtained with mouth-breathing as with nasal breathing. Here again there would seem to be individual variation. Marriott and Robson observed no difference in their own case, but in my case mouth-breathing led to considerably lower values. This is an important point, since the continued presence of the nasal catheter may tend towards nasal obstruction, so that eventually breathing may be by the mouth.

Another point is whether the forked nasal tube, which is undoubtedly more comfortable for the patient, yields as reliable results as their double nasal catheter. These are all points of fundamental importance in oxygen therapy, and now that the clinical oxygen pipette is available for analysis it is hoped to investigate them in collaboration.

The advantage of the nasal catheter or forked nasal tube is its simplicity, yet this is its chief snare. I would go so far as to say that as used in this country it is entirely ineffective in four cases out of five; the oxygen is merely wasted, for no flowmeter is employed and the rate of flow is much too slow. The head-band with the attachment devised by Marriott and Robson has the advantage of fixing the tubes, and so preventing their displacement if they are to be worn continuously; in this they are preferable to the head-band of the Davies-Gilchrist apparatus, which, however, is so simple that it can be made up in the ward. Their flowmeter also marks an advance. However, for those who have an oxygen tent it may be pointed out that the injector provides a ready-made flowmeter for use with the forked nasal tube. It is only necessary to stop the inflow ventilating tube with a cork, and to connect the outflow tube by means of an adaptor and tubing with the nasal tube. For the flowmeter to register accurately the connecting tube must not offer resistance; the bore should be at least 1/4 inch all through, and there must be no kinking of the tube.

On the whole, it may be concluded that with the forked nasal tube at 4 litres a minute an average of 30 per cent., or a little more, will be obtained for the alveolar oxygen, while it will require 5 or 6 litres a minute to raise the proportion towards 40 per cent., and 8 to 10 litres to raise it to 50 per cent. if the patient keeps his mouth shut. Ten litres a minute will mean changing a 100-foot cylinder about every four and a half hours. Children are best treated in the tent. The main use of the forked nasal tube should be for an adult patient who is not extremely ill, when 30 to 40 per cent. of oxygen is enough. It may also be used after the patient is removed from the tent, especially if the percentage of oxygen has been high. Thus the 50 or 60 per cent. oxygen of the tent will be reduced to 30 or 40, and after some hours the nasal tube may also be removed. The alternative plan is to lower the oxygen in the tent.

Technique of Using the Tent

Admittedly the oxygen tent is elaborate and skilled attention is required; this is the reason why a physicist accompanies the tent, and there are already nurses who are familiar with it. But there is no physical discomfort in the tent, and the percentage can be raised to 50 or 60 or higher with a moderate flow of 2 to 3 litres of oxygen a minute. As the patient lies in the atmosphere he is insured against any sudden change of percentage. The psychological dislike of some patients for the tent is bound to disappear in time when its use becomes familiar, except in the case of those few who object to any form of treatment. When the tent was

first introduced into one of the wards the patient, a girl of 2½ years with bronchopneumonia, was removed for washing; she used to crawl back into the tent of her own accord. Later she was left in the tent continuously. Nursing difficulties will also be solved in this country, as they have already been solved in America, where the tent is widely used; usually the patient should be disturbed as little as possible. Since there is some evidence that open ulcerations heal well in oxygen, in such cases the number of dressings can be reduced to a minimum.

Restlessness and delirium are much more formidable difficulties. A patient who has been rendered comatose by anoxaemia suddenly wakes up in oxygen, and the first reaction may be to struggle to get out of the tent. If the tent is taken away from such a patient he will almost certainly die. How can he be kept in? Much can be done by persuasion, especially if the attendant has had experience with the tent and realizes its value. But there is another consideration. If a patient in a hospital ward gets out of bed some retentive apparatus is brought, and if he makes a noise so as to disturb other patients he is taken to the "strong room." Why should not the same treatment be applied to a patient in an oxygen tent? His need is greater. Restlessness and delirium following coma are good prognostic signs, and continued treatment is indicated. After recovery the patient remembers nothing about his struggles. Again, too much is made of sleeplessness as a danger; pneumonia patients die of anoxaemia, with or without toxæmia, and not primarily because they cannot sleep. Morphine should not be given when the patient is in the tent; a dose may be fatal.

Indications for the Tent

The indications for the oxygen tent are wide, and have already been dealt with.¹ Briefly, they are as follows: in the main, pulmonary diseases, particularly pneumonia and massive collapse—spontaneous and post-operative; bronchitis, especially if associated with heart failure; whooping-cough and laryngeal diphtheria; then circulatory diseases—arteriosclerotic heart disease with failure, coronary thrombosis, and repeated anginal attacks; and poisoning by carbon monoxide, alcohol, and the barbiturates. A new indication has been recently described by Dr. Fines of the Cornell Medical Centre in New York—not yet published. If it is desired to remove the air after ventriculography or in a pneumothorax—for example, in a spontaneous non-tuberculous case—all that is necessary is to use the tent with a high percentage of oxygen—80 per cent. and over. The oxygen diffuses in, displacing the nitrogen, which by physical diffusion passes out into the atmosphere of the tent, where the partial pressure is very low; the oxygen of the pneumothorax is then rapidly absorbed by the blood. As the lung must be held in expansion until the opening into it has healed, which must take a number of hours, it would presumably be advisable to use the tent for a day or two.

The Clinical Oxygen-measuring Pipette (Poulton & Shackle)

In the description of this instrument, which is used to measure the percentage of oxygen in the tent, it was taken that an error of ± 5 per cent. might be expected.¹ There are various sources of error, most of them tending to give too low readings; these are now given for the sake of completeness. One caution in the use of the apparatus is necessary. When the rubber on the side tube begins to wear the glass rod may be sucked in, vitiating the result. It may be secured by fastening it round with a piece of pipe cleaner after setting the level at zero.

1. The effect of the elasticity of the bulb can be tested by filling the apparatus to the zero mark with the caustic potash solution without the addition of pyrogalllic acid. The level of liquid is raised to the 25, 50, or 75 mark by compressing the

bulb and the tap is turned off; on removing the external pressure on the bulb the level sinks. With the small bulb of half an ounce capacity previously in use the maximum fall was 7.5 per cent., and this decreased with an oxygen percentage greater or less than 50. A larger bulb of 25 c.cm. capacity is now used, which gives a smaller and more uniform error throughout the range of percentages used—namely, 3 per cent. with 50 per cent. oxygen and 2.5 per cent. with 26 per cent. and 65 per cent. oxygen.

2. If now, still using the caustic potash solution, a sample is taken in the ordinary way, the level of liquid will be found to be below zero mark by as much as 5 per cent., even after allowing time for the liquid to drain down the sides of the pipette. This is because the sudden release of the bulb from its contracted position draws more than 1 c.cm. of air into the apparatus. This can be minimized by keeping up the pressure on the bulb with the hand, after the liquid has been raised above the tap, until the sample has been taken, and by releasing the pressure gradually during the collection of the sample, which should last about a second. If much longer than a second elapses, absorption of oxygen will take place to a perceptible extent during the collection of the sample, which will again lead to too low a reading.

3. The air in the dead space between the level of pyrogallous acid in the capillary tube and the tent will produce too low readings; this is minimized by making the sampling tube of the tent of very fine bore and by shortening the rubber connexion as much as possible. Suction through the tube before fitting the apparatus could also be tried, but this is hardly necessary.

4. The presence of any CO₂ in the sample will make the reading too high.

5. After the absorption of oxygen sufficient time must be allowed for the fluid to drain down the side of the tube before the reading is taken; otherwise the result will be too low.

6. Sometimes a perceptible amount of the liquid is left behind in the capillary above the tap, which will also make the reading too low. This will not occur if the bore of the tap has been made sufficiently wide. There will be a similar error if liquid is left behind in the bore of the tap, which may happen if the sample has been taken in too quickly.

TABLE IV

Clinical O ₂ Pipettes					Haldane	Difference
1	2	3	4	Average		
Percent.	Percent.	Percent.	Percent.	Per cent.	Per cent.	Per cent.
65	65	65	64	64.8	68.7	3.9
47	48	45	49	47.1	51.0	3.9
61	63	—	—	61.2	67.6	6.4
61	60	—	—			
48	50	47	46	47.8	52.7	4.9
37	38	36	37.5	37.1	42.0	4.9
36	38	38	36	37.0	42.4	5.4
16	16	15	15	15.5	20.5*	5.0

* Air sample taken from small room with closed windows. Sample from outside air gave 20.8 per cent. including CO₂.

To estimate the actual error the air in the tent was enriched with oxygen and samples were taken for analysis in the Haldane apparatus and in four clinical oxygen pipettes (Table IV). The pyrogallous acid was raised to the top of the capillary and the bulb of the pipette was supported by the hand until the sample had been removed. The readings were taken two to three minutes after mixing, and no further change was noted within five minutes. The results are seen to be consistent, and on the average about 5 per cent. below the Haldane measurements. When a much longer time was allowed for draining the level rose by 1 per cent.

Whereas the error of the pipette in the case of the higher oxygen percentages is fairly constant, the same is not the case when atmospheric air is analysed, and variations ranging between 5 and 1 per cent. have been found on different occasions. This is of no great consequence, since the apparatus will not ordinarily be used for these lower percentages. In spite of this variation the results have been consistent in themselves on each occasion. One series with a difference

of 5 per cent. is shown at the bottom of Table IV. At another time the percentages were 20, 20, 20, and at another time 18, 18.5, 18, 17.5. Presumably variations in the elasticity of the bulb are responsible, but this has not been investigated.

In the ordinary clinical use of the apparatus it may be assumed that all readings are 5 per cent. too low. Thus 5 per cent. should be added to all readings, or, in the first place, the level may be adjusted so that the zero coincides with 5 per cent. on the scale, and no correction is then made in the final reading. The error in the final reading is probably less than ± 5 per cent. Greater accuracy is unnecessary in clinical work.

Note.—The best way to fill the oxygen pipette is to clamp it upright in a stand, and to attach to the nozzle, by means of a rubber connexion, a very small funnel or pipette to hold the pyro. solution. On alternately squeezing and relaxing the bulb the required amount runs down into the pipette. The final adjustment of the zero is made by moving the glass rod in the side tube.

The Clinical CO₂-measuring Pipette

Occasional analyses of the CO₂ in the tent are required to show when the soda lime is becoming exhausted and if CO₂ is used in treatment. A fuller study with this pipette shows that it, like the oxygen pipette, is apt to give too low results. The only possible explanation would seem to be that some CO₂ is absorbed by the water before the first reading is made. London tap water is on the alkaline side, and the difference between the CO₂ determinations with the pipette and with the Haldane are considerable, as shown in Table V. There

TABLE V

Pipette	Analysis with:				
	CO ₂	Haldane	CO ₂	Difference	Per cent.
2.49		3.37		0.88	26.0
3.05		3.57		0.52	14.5
0.70		0.83		0.13	15.7

was still some difference when the tap water was acidified, but it was less—namely, 10 per cent. on the average (six determinations). This means that if the actual value of CO₂ was 3 per cent. the pipette would read 2.7 per cent. The simplest way to acidify the tap water is to run a little weak acid solution from the funnel into the pipette just before taking the sample.

Conclusions

1. The recent modifications in the Guy's oxygen tent are designed to prevent the patient from being disturbed when the tent is applied, to facilitate nursing, and to preserve airtightness. Periodical analysis of the air of an oxygen tent is essential.

2. The forked nasal tube is more comfortable than any type of nasal catheter, but much more oxygen is required than with the oxygen tent. Indications for both tube and tent are suggested.

3. The accuracy of the clinical oxygen and CO₂ measuring pipettes has been further investigated, and certain sources of error have been pointed out.

Finally I should like to thank Mr. T. W. Adams for his help and Dr. H. L. Marriott and Dr. K. Robson for their collaboration in part of the work. The incidental expenses were defrayed by a grant from the Medical Research Council.

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The third International Congress on Light will be held at Wiesbaden from September 1st to 7th, under the presidency of Professor Dr. W. Friedrich, head of the Institut für Strahlenforschung of the University of Berlin. Problems will be dealt with relating to the whole field of the biology of light, of biophysics, and the therapy of light. Inquiries should be addressed to the secretary-general, Dozent Dr. H. Schreiber, Berlin, N.W.7, Robert Koch-Platz 1.