the Tropical School of this university by the generosity of Sir Edwin Durning-Lawrence, Bart. In this chamber we exposed a number of guinea-pigs which had been inoculated with tuberculosis to a temperature of 0° C. to -5° C., while another set were kept in air at ordinary temperatures, and a third set in an atmosphere enriched by oxygen. It was found that the tuberculous lesions developed most rapidly of all in the animals kept in the cold chamber. At that time we were anticipating the opposite result, but there is no doubt whatever in our minds as to the results of the experiments—namely, that keeping in a cold atmosphere does not by itself alone inhibit the growth of the tubercle bacillus, but rather the reverse.

What is, then, the mode of action of the fresh air treatment? There is nothing different in the chemistry of the air, and it would appear as if it administered a purely physical stimulus to increased pulmonary ventilation, due to the reflex nervous effects of the draughts of cold air playing upon the face.

The lassitude due to confinement in heated rooms, and its removal by fanning or movement of the air, have been explained in this way by Leonard Hill, who has shown that the accumulation of carbon dioxide in the air of occupied and heated rooms has nothing to do with the matter. The cooling by convection and evaporation from the skin of the face leads to increased respiration, and removes at once the feeling of lassitude and oppression.

It may next be asked in what way does increased pulmonary ventilation affect the tubercle bacillus, and it may be pointed out that it is not purely by increased uptake of oxygen, for, as has been stated above, animals left even in an atmosphere of oxygen in a resting condition have no more oxygen in their blood than when breathing air, and develop tubercle, as Adams has shown, just as rapidly as other animals in ordinary air.

The other effect is increased movement of the lungs, leading to increased lymph flow, and hence increased rate of oxygen access to the actual site of the tubercle.

It is this action which, in our opinion, gives the beneficial action of the fresh air treatment. Without such a stimulus a patient cannot by voluntary effort in any breathing exercises keep up for any length of time an increased ventilation; he becomes apnoeic, and the respiration diminishes automatically. For this reason some experimentation would appear necessary upon the subject of how best to administer the cool air in drafts or puffs over the face so as to keep up the stimulus most effectually and for the longest period, and as to what alternations are of most advantage in such administrations of fresh air.

The same effects are seen at work in the treatment of phthisis by high altitudes, where the oxygen supply is considerably less than at sea-level. Here the patient is compelled vigorously to ventilate the lungs in order to obtain sufficient oxygen, especially if any light exercise be taken. It is certainly not in this case an enrichment of oxygen. But the changed conditions are such as to give more oxygen locally where it is wanted—namely, in the lymphatic spaces of the lungs where the tubercle bacillus is situated. The over-ventilation alternately distending and collapsing the lung tissues sends a rapid stream of lymph along bearing more oxygen in solution past the tubercles. At a high altitude the cooler air also plays its part in inducing increased ventilation of the lung, and the two effects work together.

If this view be the correct one, the things to be aimed at in treating phthisis are such as will secure increased oxygenation at the site of the tuberculous lesion. This is obtainable by hyperaemia of the affected area and increased lymph flow at that part. In regard to the vascular circuit as a whole, the resistance should be so affected, if possible, that the pressure is increased in the pulmonary capillaries before the alveolar areas are reached, and the systemic circuit should be vaso-dilated, so as to send the blood to the pulmonary region as highly oxygenated as possible. Next, the ventilation in the lung should be increased as much as possible so as to cause a mechanical lymph flow. The body of the patient should be kept warm, and the face, if possible, subjected to rhythmic applications of cool air at such a rate as to stimulate respiration. Exercise should be indulged in to that extent to which it will somewhat stimulate ventilation without loading up the system with unoxidized products by making too great a demand

upon oxidation, and this exercise possibly might best be in the open air, alternated with the cold air applications.

REFERENCES.

- ¹ *Bio-chemical Journal*, vol. iv, 1909, p. 177; vol. v, 1910, p. 181.
² *Ibid.*, vol. vi, 1910, pt. 11. ³ *Proc. Roy. Soc., B*, vol. lxxxv, 1912, p. 56.

EXPERIENCE OF THE DIORADIN TREATMENT.

A REPORT UPON TEN PATIENTS WHO RECEIVED THE TREATMENT.

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DIORADIN is a combination of chemical substances introduced for the treatment of tuberculous affections by Dr. Szendeffy, of Budapest.

An announcement of its alleged marvellous efficacy was made in the English lay press in May, 1911. Some allusions to its composition were made in the *BRITISH MEDICAL JOURNAL* at that time.

At the beginning of August Dr. Bernheim came to England. Dr. Bernheim is President of the French Department for the dealing with human tuberculosis and Chief Physician of the French antituberculosis dispensaries, and he came with credentials from the English Ambassador in Paris.

I had the pleasure of a long interview with Dr. Bernheim, and he very kindly provided me with a supply of the dioradin sufficient for the systematic treatment of ten patients.

He assured me that, though he had given several thousands of injections, he had never seen any ill effects, and he was enthusiastic with regard to the beneficial results. In these circumstances I felt that it was my duty to test the method of treatment.

Dioradin is said to contain peptonized iodine, menthol, ethereal solution of radium barium chloride, and almond oil.

It has been said that peptonized iodine is a compound unknown to chemists. Dr. Bernheim explained that the substance indicated is what we term iodo-albumose. Menthol is a stearoptene; it is somewhat loosely described by Dr. Szendeffy as a terpene, but terpenes and stearoptenes are not far apart chemically, both being derived from essential oils. The critic in the *BRITISH MEDICAL JOURNAL* said that he could not find any terpenes on analysis of dioradin, but recognized the presence of menthol. Radium barium chloride is soluble in ether, and is added in solution. The excipient is almond oil.

Dioradin is an oily fluid, smelling strongly of menthol, with a suggestion of iodoform. Dr. Bernheim told me, however, that iodoform was not present. Dr. Melville found at the Brompton Hospital that dioradin has some radio-activity.

Dioradin is administered by intramuscular injection with aseptic precautions. The dose is 1 c.cm., given daily for thirty days, followed by fifteen more injections on alternate days. If necessary, a further course may be given after a period of rest.

The contraindications to the use of the preparation are said to be disease of the heart or kidneys, but no record of ill results from its use in such cases is given in Dr. Bernheim's report. Symptoms of iodism and diarrhoea call for cessation of treatment, but again the report does not include any examples of these complications, and Dr. Bernheim told me that he had not met with any.

The cases were selected for the treatment with great care, and represented common types of the disease. In all the diagnosis of tuberculous infection was certain; in the 9 cases of pulmonary tuberculosis tubercle bacilli had been found in the sputum, and in the case of tuberculous peritonitis and epididymitis the clinical characters leave no room for doubt as to the diagnosis.

In none of the cases has any ill effect, either general or local, followed the injections. Several patients said that they could taste the injections for some time afterwards, and in one or two cases there was a slight increase of cough after a few days.

Dr. Bernheim gives ten conclusions as a result of his observations of the use of dioradin:

1. It destroys Koch's bacillus. He states that under treatment tubercle bacilli in the sputum become less numerous or disappear altogether.
2. It destroys streptococci.
3. It improves the general condition.
4. It increases the strength of the patient.
5. It increases the weight.
6. It continues to do good in spite of intercurrent affections.
7. It cures tuberculous adenitis.
8. It helps tuberculous laryngitis.
9. It acts locally in pulmonary tuberculosis, suppressing the cough, diminishing the sputum, and removes the fever and night sweats.
10. It regulates the gastric functions.

CASES TREATED BY DIORADIN.

1. Early Apyrexial Type (*Ambulant Afebrile*).

Frank H., aged 19, an engineer's apprentice, was admitted to the Brompton Hospital on August 2nd, 1911.

History.—He had coughed up half a pint of blood in January, 1911, since then slight cough and expectoration had persisted, with three more slight attacks of haemoptysis.

On admission there were signs of infiltration of the apices of the upper and lower lobes of the right lung, with numerous crepitations. There was some impairment of resonance but no crepitation at the left apex. Tubercle bacilli were present in the sputum in large numbers.

The temperature varied between 97° and 98.8° F.

Daily injections of dioradin were commenced on August 5th. He complained at first that some headache followed the injections, but later there was no such complaint.

On August 28th he had gained 2½ lb.; there was practically no cough and no expectoration. The sputum was re-examined, and a few tubercle bacilli were found on the second slide.

The temperature for the last week remained at 97° F. The crepitations at the right apex were no longer audible.

On September 1st he was sent to the sanatorium at Frimley. While at Frimley two more series of injections of dioradin were given, each of fifteen injections on alternate days. He left Frimley in November; the cough persisted, but there was very little sputum. While at Frimley he gained 10 lb. in weight.

On January 5th, 1912, the sputum was examined and found to contain tubercle bacilli.

On May 22nd, 1912, his mother wrote that after leaving Frimley he appeared to be in the best of health and started work (engineering). After three weeks, pyrexia commenced and the sputum increased. He was given light work in the open air. He did not improve and had an attack of haemoptysis, and had been in bed for five weeks.

Recently he has wasted considerably. His temperature varies from 99° to slightly above 101°.

2. Apyrexial Fibrous Type (*Chronic Ambulant Afebrile*).

James S., aged 39, carman. Admitted to the Brompton Hospital on August 4th.

History.—Haemoptysis (4 oz.) four years ago with a cough lasting about a week. No return of symptoms until April, 1911, since when he has had a cough with expectoration occasionally streaked with blood.

On admission there were signs of infiltration with fibrosis of both lobes of the left lung to the fifth rib in front and the angle of the scapula behind. There was also evidence of infiltration of the apex of the right upper lobe. Tubercle bacilli were present in the sputum on August 5th.

The temperature varied between 98° F. and 99° F., reaching 99° F. on six occasions between August 4th and 14th.

Daily injections of dioradin were commenced on August 14th.

Report on September 1st.—Fewer rales to be heard in the chest. Weight has increased from 9 st. 13 lb. to 10 st. 2½ lb. Cough and expectoration less; tubercle bacilli still present. Temperature usually subnormal, reaching 99° on August 16th and 17th, but not subsequently.

The first course of thirty daily injections of dioradin was completed on September 13th. On that date it was noted that the cough was troublesome, the temperature was steady, the weight had increased by 4½ lb., and the physical signs were practically unchanged.

Between September 17th and October 12th he had a second course of fifteen injections given on alternate days.

On October 12th it was noted that the added sounds were no longer audible at the right apex, though the signs in the left lung remained as before. There had been a further gain of weight of 7½ lb.

On October 17th a course of bacillary emulsion was started (0.00002 c.cm to 0.003 c.cm).

He left the hospital on November 1st. The notes record that there were no moist sounds audible over the right lung, but that the left lung was in the same condition as on admission. There was no cough; he felt very well and had gained 12½ lb. while in the hospital. On January 1st he was still working; he had gained a further 6 lb. in weight, had very little cough or sputum. The sputum, however, still contained tubercle bacilli.

On May 22nd, 1912, he reported that he felt quite well, had no cough to speak of, and brought up very little phlegm.

He had not consulted a doctor since leaving the hospital, and had not taken any medicine.

He is not doing much work owing to the difficulty of obtaining any. A month ago he did a fortnight's hard work, and did not feel any the worse for it. Present weight, 12 st.—an increase of over 2 st. since August last.

3. Apyrexial Fibrous Type (*Ambulant Afebrile*).

Henry H., aged 38, railway guard. Admitted to the Brompton Hospital on June 21st, 1911.

History.—Cough and expectoration for eighteen months; no haemoptysis.

On admission there were signs of infiltration with some excavation and fibrosis of the upper and lower lobes on the right side and of the upper lobe on the left side.

Tubercle bacilli were present in the sputum on June 24th and on August 8th.

The temperature between June 21st and August 5th ranged between 97° F. and 99° F., reaching 99° F. on fourteen occasions. Daily injections of dioradin were commenced on August 5th.

Report on August 28th.—A few fine crackles to be heard at each apex. Between June 21st and August 7th (no special treatment) the weight had increased 10 lb.; since August 7th there had been a further gain of 3 lb.

Tubercle bacilli were present in sputum on September 2nd, but were scanty.

Between August 5th and September 1st the temperature ranged between 97° F. and 98.6° F., never reaching 99° F.

The patient said that he could taste the dioradin a few minutes after the injection, and he thought that it led to a slight increase of the cough.

Since his discharge it has not been found possible to get any information with regard to this patient. Letters elicit no reply.

4. Apyrexial Fibrous Type (*Ambulant Afebrile*).

Ernest W., aged 29, clerk. Admitted to the Brompton Hospital on June 20th, 1911.

History.—Cough, with expectoration and loss of weight persisting since December, 1909.

On admission there were signs of excavation with fibrosis at the apices of both lobes of the right lung, and of slight infiltration of the apex of the upper lobe of the left lung. Tubercle bacilli were found in the sputum on June 27th. From June 20th to August 5th the temperature ranged between 97° and 99° F., reaching or slightly exceeding 99° F. on twenty-three days. On August 5th, when the dioradin treatment was commenced, the cough and expectoration had diminished considerably; there were fewer rales audible in the chest, and the weight had increased 1½ lb.

Report on September 1st.—Cough somewhat increased; no rales heard in the chest. Weight had dropped 1 lb. Temperature 97° to 99° F., reached or exceeded 99° F. on fifteen days—that is, has not been steadied by the injections.

Tubercle bacilli were present in sputum on September 2nd. After 30 daily injections a second course of 15 injections on alternate days was given. On September 18th he was sent to Frimley.

January 20th, 1912. The patient is still at Frimley; he has had to be confined to bed on several occasions on account of pyrexia. The cough was much less, and only troublesome in the early morning; the sputum was reduced to about an ounce and a half per diem. The weight had increased another pound. Tubercle bacilli present in the sputum on January 18th.

February 9th, 1912. He left Frimley. The temperature was normal; sputum about two ounces per diem; weight increased two more pounds; few added sounds were heard over the lungs.

May 22nd, 1912. He reported that he had been fairly well since leaving Frimley, but that he had been feeling seedy for the last few days. The morning temperature varies between 97.2° and 98°, and the evening temperature between 98° and 99°. The sputum was still about one and a half ounces daily. The weight had dropped about 10 lb. The cough had been troublesome, especially after meals, and there had been some vomiting in the evening.

5. Apyrexial, but with Ready Pyrexial Response (*Resting Afebrile Ambulant Febrile*).

Annie E., aged 27. Admitted to the Brompton Hospital on July 28th.

History.—Cough, with some expectoration, since 1909. No haemoptysis.

On admission there were signs of infiltration of both lobes of the left lung, as low as the sixth rib in front and the angle of the scapula behind. There was also some infiltration of the apex of the right upper lobe.

Tubercle bacilli were found in the sputum on July 30th. From July 28th to August 5th the temperature ranged from 98° F. to 99.6° F. Treatment commenced on August 5th.

Report on September 1st.—Cough somewhat increased by the injections, which seemed also to give rise to some giddiness. Weight 1 lb. less than on admission. Temperature 97.6° to 99° F., rather lower than before the injections were given, but is still irregular.

Tubercle bacilli present in sputum on August 15th and September 1st. After the completion of the first course of thirty daily injections a second course of fifteen injections on alternate days was given.

On September 27th the temperature was still slightly irregular, and there was still some cough. The signs in the chest had not altered since admission to the hospital.

The second course was finished on October 4th. After its cessation the temperature became steadier.

She was discharged on October 23rd. The last note records that the right side of the chest was dry, and the left side drier than on admission. Tubercle bacilli were present in the sputum on October 22nd.

Total gain of weight while in hospital was 4½ lb. On January 18th she reported that the cough was worse, and that she had been confined to the house for some weeks; there was a large quantity of sputum, and tubercle bacilli were present. The temperature rose to 100° F. each evening.

Since then letters have not elicited any reply.

6. *Pyrexial, but with Ready Pyrexial Response (Resting Afebrile, Ambulant Febrile).*

Arthur F., aged 19, potter. Admitted to the Brompton Hospital on August 11th.

History.—Cough and expectoration since April, 1911. No haemoptysis. Recently has been living in a cottage in the country and has gained weight.

On admission there was evidence of infiltration of upper and lower lobes of the right lung and of the apex of the upper lobe of the left lung.

Tubercle bacilli were present in the sputum on August 18th. The temperature up to August 20th ranged between 98° F. and 99.8° F.

Daily injections of dioradin were commenced on August 20th.

Report on September 1st.—Physical signs unchanged. Weight gained since admission, 9½ lb. Tubercle bacilli present in sputum on September 1st. Temperature more irregular since injections were commenced, varying from 98° F. to 100° F. There were no symptoms referable to the injections.

The first course of injections was finished on September 20th. The moist sounds audible in the chest were then fewer than on admission, and the weight had increased 5½ lb.

A second course of fifteen injections on alternate days was then commenced. This was completed on October 20th. On that date the physical signs remained unchanged; the weight had increased by 3½ lb.; the cough was still troublesome.

He left the hospital on November 10th, having gained another ½ lb., a total gain of 9½ lb. since admission. On January 18th, 1912, he reported that the cough was about the same as on discharge, but that the sputum had increased. He had lost 4½ lb. in weight. Tubercle bacilli were still present in the sputum. On May 22nd, 1912, the cough was described as "racking," the sputum had increased, and the weight had dropped 12½ lb. since January.

7. *Pyrexial Type (Resting Febrile).*

Elsie H., aged 19, saleswoman. Admitted to the Brompton Hospital on July 7th, 1911.

History.—Cough and expectoration since January, 1911. Worse for the past month. Sputum occasionally streaked with blood. Father died of pulmonary tuberculosis two years ago; mother tuberculous (Case 8).

On admission there were signs of infiltration of both lobes of the left lung and of the upper lobe of the right lung.

Tubercle bacilli were present in the sputum on July 10th. From July 10th to August 10th the temperature ranged from 98.6° F. to 100° F., 101° F. or 102° F., and the weight fell 4 lb.

On August 10th the physical signs were as on admission. Daily injections of dioradin were commenced on August 10th. Absolute rest, and Lees's inhalation also.

Report on September 1st.—The physical signs were unchanged. At first the injections caused some headache, but not lately. The cough was easier and she felt better.

Tubercle bacilli were present in the sputum on September 1st. The temperature during the course ranged from 99° F. to 100° F., 101° F. and 102° F.; the injection seemed to have no influence on the pyrexia.

The course of thirty injections was finished on September 8th. During the course the temperature rose frequently to 102° F.; after the last injection the temperature began to fall gradually, reaching normal at about September 16th; on September 18th absolute rest ceased, and on September 25th she got up for one hour.

The disease remained afebrile until she left the hospital for Ventnor on November 27th. While in the hospital she lost 11 lb. in weight, though during the last two months—that is, after the cessation of the dioradin—she gained 3 lb. Tubercle bacilli were present on November 25th.

On January 12th a report from Ventnor said that she was keeping pretty well, though the cough was troublesome.

She remained at Ventnor (St. Catherine's) until March 30th. Since then she has been in the country with friends. The cough is troublesome, and on May 22nd, 1912, she weighed the same as on admission to Brompton. She feels very well, but owing to the cough is unable to do any business.

8. *Pyrexial Type (Resting Febrile).*

Emma H., aged 42, widow. Admitted to the Brompton Hospital on July 14th.

History.—Cough and expectoration since June, 1909. In Victoria Park hospital in 1909, improved. Getting worse since June, 1911. Husband died of pulmonary tuberculosis in March, 1909. Daughter has pulmonary tuberculosis (Case 7).

On admission there were signs of infiltration without softening of both lobes of the left lung and of the upper and lower lobes of the right lung, with some crepitation beneath the right clavicle.

Tubercle bacilli were present in the sputum on July 17th. From July 14th to August 10th the temperature ranged from 98.4° F. to 100° F. or 101° F., and during this period she lost 2½ lb. in weight. Daily injections of dioradin were commenced on August 10th.

Report on September 1st.—Physical signs unchanged. Tubercle bacilli present in sputum on September 1st. Weight stationary. At first the injections caused an increase of the cough and some headache. The cough is still troublesome. The temperature has been somewhat higher since the injections were commenced, seldom reaching normal.

The thirtieth injection was given on September 8th. After cessation of the injections the temperature became somewhat steadier. Signs of excavation gradually developed in the left lung, and on September 27th a definite diagnosis of cavity in the left lung was made. The case now was afebrile when resting, but febrile when the patient got up.

On October 16th it was decided to produce an artificial pneumothorax. Between that date and May 22nd the operation was repeated eight times, 500 to 1,200 c.cm. of nitrogen being introduced on each occasion. The case soon became afebrile; weight increased, and the cough diminished.

Tubercle bacilli were found in the sputum on January 12th, 1912.

On May 22nd the temperature had been normal for weeks. The cough was much less, and the sputum was reduced to 1 oz. per diem. She weighed 10 lb. more than on admission. There were signs of a left hydro-pneumothorax.

Tubercle bacilli were present in the sputum on May 6th. The patient is now at Frimley.

9. *Chronic Fibro-caseous Type (Resting Febrile).*

John McD., aged 35, a labourer, was admitted on June 21st, 1911.

History.—He had had a winter cough for years; this had not disappeared during the last summer. There was free expectoration, but no haemoptysis. There were signs of excavation in the upper part of both lobes of the right lung and of infiltration almost to the base, and also of infiltration of the apices of both lobes on the left side.

The temperature was irregular, rising at first to 102° in the evening, and falling to normal in the morning. After a few days it became steadier, generally reaching 99° in the evening.

During the first month he improved considerably, and at the end no moist sounds were heard over the left lung. Tubercle bacilli were present in the sputum. On August 5th a course of daily injections of dioradin was commenced. After the commencement of the injections the temperature became, and continued, subnormal. The cough remained rather troublesome, and on September 2nd the sputum still contained tubercle bacilli.

Before the course began he had gained 3½ lb.; afterwards he gained 5½ lb. more.

A second course of injections on alternate days was commenced on September 7th, but only six injections were given, because he discharged himself from the hospital. There were fewer moist sounds audible in the chest than on admission.

Two days after reaching home he was taken ill with severe pains in the side and high fever. He died on November 6th.

10. *Tuberculous Epididymitis and Peritonitis.*

Reginald T., aged 15, double tuberculous epididymitis and ascitic form of tuberculous peritonitis. No evidence of pulmonary tuberculosis.

A course of injections of dioradin was given between August 14th and September 13th. The temperature, which was intermittent before the course began, swinging from 97° to 100°, was not affected by the injections. The patient could taste the dioradin shortly after each injection, otherwise no immediate or remote effect could be discovered. The local signs of disease showed no change.

On October 2nd laparotomy was performed and 62 oz. of fluid evacuated. After the operation he began to gain weight and left the hospital weighing 25 lb. more than on admission.

On January 17th, 1912, he was found to be not so well—the abdomen had swollen again and there was some albuminuria, arousing suspicion of amyloid disease.

On May 22nd, 1912, his father reported that his general condition had improved in strength and energy. He was able to walk more upright and the legs were less swollen. The intestinal symptoms were less troublesome.

CONCLUSIONS.

The claims made on behalf of dioradin may be reviewed seriatim:

1. In one case of pulmonary tuberculosis (No. 1) the tubercle bacilli, which were numerous in the sputum on admission, were difficult to find at the end of a month, but were still present five months later.

In the other eight pulmonary cases the tubercle bacilli were still present in the sputum so long as the patients remained under observation.

2. The action on streptococci was not tested. One patient suffered from acne which was not benefited by the treatment.

3. In six cases improvement was recorded during the treatment. In one of these the improvement has been

maintained (No. 2); four relapsed later (Nos. 1, 4, 5, 6), and of one (No. 3) no subsequent report has been obtained.

In one case there was slight improvement during treatment (No. 9), but the patient died shortly after leaving the hospital.

In three cases (Nos. 7, 8, 10) there was no obvious improvement during the continuance of the treatment.

In none of the cases was there evidence of complete arrest of the disease.

4. The strength improved with the general condition, and the remarks under the last heading may be applied here.

5. Seven patients gained weight during the treatment; one (No. 2) has continued to do so; three lost weight (Nos. 1, 4, and 6) subsequently, and of two there is no further report.

Two patients (7 and 8) lost weight during the treatment, but gained weight subsequently. In the case of tuberculous peritonitis there was a gain in weight after the operation.

6. None of the cases developed intercurrent affections, and this assertion could not be tested.

7. No case of tuberculous adenitis was treated; the case of tuberculous epididymitis and peritonitis did not seem to be influenced by the treatment.

8. No case of tuberculous laryngitis was treated.

9. Evidence of local action was difficult to find. In Case 3 the patient said that he could taste the dioradin a few minutes after the injection, and thought that it slightly increased the cough. In Case 8 it seemed to increase the cough.

In other cases the cough and sputum diminished. In Cases 7 and 8 there was no reduction of the pyrexia during the treatment, but the cases became afebrile after its cessation. In none of the cases were night sweats a prominent feature.

10. It was not possible to recognize any effect, good or bad, upon the gastric functions.

It does not seem to me that any of the cases, though they were treated accurately in accordance with the instructions, can be quoted to justify any claims for the therapeutic efficacy of dioradin.

I have to thank Dr. Hartley for permission to make use of the cases which were under his care, and Dr. Tattersall for his assistance in giving the injections and following up the cases.

ANAESTHESIA BY THE INTRATRACHEAL INSUFFLATION OF ETHER.*

BY

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In the year 1660 Hook showed that if the mouth of a bellows was tied into an animal's trachea, the chest walls removed, and the lungs extensively punctured, it was possible by inflating the lungs to keep the animal alive in the absence of efficient respiratory movement. Further, in birds whose bones are air sacs in communication with the trachea, it is possible to restore animation after both sides of the thorax had been opened by forcing a draught of air through one of the long bones.

It remained, however, for Meltzer and Auer about eighteen months ago to show that if air is forced under pressure through a tube passed through the glottis without entirely occluding it, life could be maintained without respiratory movements either when these movements were paralysed by curare or rendered ineffectual by opening both sides of the chest.

Though the movements of breathing change the air in the trachea and larger bronchi, the real respiration is an interchange of gases by diffusion. The partial pressure of oxygen in the trachea is greater than the partial pressure in the alveoli, which is again greater than the partial pressure of oxygen in the tissues. For carbon dioxide the exact reverse holds good. Therefore there is always a diffusion of oxygen from the air to the tissues, and a

corresponding diffusion of carbon dioxide from the tissues to the atmosphere.

Now if we can supply a continuous stream of air under pressure at the lower end of the trachea, the diffusion of oxygen will go on without respiratory movements. A catheter about half the size of the glottis is passed down the trachea until it reaches the bifurcation. The catheter is connected with a forced draught of air from 10 to 40 mm. Hg pressure, the air having previously been warmed, moistened, and etherized. The excess of air escapes between the catheter and the glottis.

In the experimental surgical laboratories, principally in America, almost incredible operations have been done on dogs by Carrel, Guthrie, Crile, Meltzer and others by using this method of intratracheal insufflation of etherized air—operations such as the complete removal of one or more lobes of the lung, complete division and suture of the thoracic oesophagus, and complete division and suture of the transverse arch of the aorta. To enable the latter to be done a temporary anastomosis was established between the left ventricle and descending aorta, in order to keep the nerve cells of the brain and cord alive during the stitching.

It is to Elsberg of New York that we owe the first apparatus for use on the human subject, and the instrument here illustrated is the Elsberg model, with some slight modifications of my own.

Though invented primarily for use in thoracic surgery and to displace the positive and negative pressure cabinets of Sauerbruch and Meyer, in practice it has been found so useful in other respects that, as a means of maintaining anaesthesia in difficult cases, it possesses advantages found in no other method. Its advantages are:

1. That the current of air at the glottis is outwards. The air enters through the catheter and escapes between the catheter and the opening of the glottis. Against this current no blood, mucus, or vomit can possibly find its way into the air passages, so that in difficult mouth, tongue, jaw, and goitre operations, or cases of intestinal obstruction, there is not the slightest danger of any foreign material gaining entrance to the lungs.

2. That in mouth and neck operations the surgeon is in no way interfered with by the hands of the anaesthetist, for a tube alone connects the patient with the apparatus, which may therefore be placed at any distance from the operating table.

3. That in those diseases where respiration fails life can still be maintained. It is possible to give a dog twice the lethal dose of strychnine and yet keep him alive in spite of the spasm of the respiratory muscles. In a case of myasthenia gravis, reported by Elsberg, where respiration failed on account of paralysis of the respiratory muscles, a patient was kept alive for some twelve hours after all normal respiratory movements had ceased. There is no doubt that in the future, whenever available, this method will replace the present system of artificial respiration by manual means, especially in cases of poisoning and tetanus.

4. That chest surgery now becomes practicable in the absence of either a Sauerbruch or Meyer cabinet.

The apparatus consists of a $\frac{1}{2}$ -horse power electric motor, A, actuating a blower, B, rotating it about 500 times per minute. This blower is a "Hypress" blower, size 00, and is really a vacuum cleaner rotating the wrong way. It produces a blast, not a vacuum. The air from the blower is then passed into the chamber C, where it is freed from its oil and dust by being passed through water. The air is then carried on to the ether chamber, D. This is what motorists would call a surface carburettor. By means of the three taps gearing to one another and connected with the pointer, the air either passes entirely over the surface of the ether when the pointer is at "full," or misses the ether altogether when the pointer is at "0." At any intermediate position only a portion of the air is etherized, the amount depending on the position of the pointer. As a rule, to maintain anaesthesia it should be placed about half-way.

The etherized air from D is warmed and moistened by passing through a coil of lead tubing placed in warm water and containing in the circuit a moistened piece of gauze. This chamber E is kept warm by means of a small electric "hot-plate" controlled by a switch. A manometer and a thermometer are now placed in the

* Read at the Liverpool Medical Institution, April 25th, 1912.