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.

circuit, so that it is possible to see at what pressure and temperature the air enters the lungs.

The patient having been anaesthetized in the ordinary way, the tracheal catheter is passed. This is an ordinary coudé catheter of a size from 18 to 26 French. It should be half the diameter of the glottis, and for adult males a No. 22 is suitable.

This catheter is passed by direct laryngoscopy, a Chevalier Jackson's instrument, with distal illumination, being used. It is done in a few seconds. If the catheter is too soft a stylet makes its introduction easy. On the catheter are two marks, 12 and 26 cm. from the tip, for it has been found that these distances are the usual distances to the glottis and bifurcation of the trachea respectively from the incisor teeth. As a rule the distance to the glottis is just about half that to the bifurcation, so that if the distance to the glottis is noted the catheter must be passed just as much again in order that its tip should be in the right place. In order to prevent the catheter from being bitten it must be protected by a "bit." I have found that a Smith's gag without the tongue depressor very useful for this purpose, and to prevent the catheter from being coughed out it is attached to this gag by a small bulldog forceps which does not compress its lumen. The catheter is now connected with the current of air and the ether

Front view.

turned on. In order to maintain efficient surgical anaesthesia, I find that the pointer should be about half way.

The reflex of breathing still goes on, but the movements are light. In deep anaesthesia they are sometimes very light; still, the internal respiration goes on, and the patient's colour remains a healthy pink. The depth of the anaesthesia is judged by the corneal reflex and the reaction to light.

As soon as the operation is finished pure air is turned on, and the ether, so to speak, flushed out. This flushing with air is said by most observers to make the recovery time from anaesthesia very short, and in some of our cases the patients were able to talk rationally within half an hour after the end of the operation.

If there is any cyanosis it means that the catheter is too large, and this is generally also shown by the fact that the manometer reading is too high. A smaller tube will suffice to put this right. As a rule the manometer reading should be from 10 to 40 mm. Hg. This pressure of course should not be absolutely continuous, for this would lead to embarrassment of the heart by not allowing the respiratory pump action on the venous circulation in the thorax, so the anaesthetist three or four times a minute allows the pressure to drop to zero by opening the tap x. In Dr.

Janeway's instrument, which I had the pleasure of seeing in New York, this safety valve action is automatically controlled so as to be performed a definite number of times per minute.

The working of the apparatus is very simple. The anaesthetist watches the reflexes and alters his pointer accordingly, whilst two or three times a minute he opens the safety tap to reduce the pressure to zero. If the temperature of the air entering the lungs drops or rises, then a switch operating the electric heater will put it right again, and if the pressure is not correct, then the mere turning of the tap on the blower will raise or lower the pressure at will.

In a case of malignant disease of the floor of the mouth, in which 4 in. of the lower jaw had to be removed, the anaesthesia by this apparatus was perfect and uninterrupted, and not the slightest anxiety was felt about blood getting into the pharynx.

In goitre operations it answers admirably. Rarely, if ever, under open ether are these operations unattended by some cyanosis, especially when the trachea is interfered with, but in the two goitre operations in which I have used this apparatus the colour of the patients was excellent during the whole operation.

In both these cases of goitre there was huskiness for a day or two after the operation, but on no other occasion has this after-effect been observed.

I was able to contrast the effect of open ether with the insufflation method in the case of an old man with enlarged prostate. After the preliminary suprapubic cystotomy performed under open ether the patient had bronchitis for some five days, whereas after the second operation, a much longer procedure, performed with insufflation, not the slightest sign of bronchitis was noticeable. Indeed, on passing the tracheal catheter the blast of air cleansed his

Back view.

air passages by blowing a large quantity of sputum into his mouth.

In abdominal operations and in hernia the relaxation of the abdominal muscles is complete, and the reaction time is quicker—that is, if the surgeon wishes the abdominal walls more lax, this is procured in a few seconds by turning on more ether.

So far as a small experience of 25

cases can go, the result of using this apparatus is that patients recover more quickly, the after-effects are lessened, vomiting has only been noticed once, and from the surgeon's point of view the anaesthesia is perfect. Further, the anaesthetist has a greater sense of security, for if at any time he thinks that artificial respiration may be necessary, he has the apparatus ready to hand, and has merely to turn the pointer from "ether" to "air."

My thanks are due to Dr. Janeway, of New York, for

procuring me the "hypress" blower, and for many valuable hints; to Mr. Nesbitt, of the Thompson Yates Laboratories, for making my instrument; and to my colleagues, Messrs. Thelwall Thomas, Bickersteth, Litler Jones, F. Jeans, and H. Woolfenden, for allowing me to anaesthetize some of their patients.

ACUTE EPIPHYSITIS.

BY

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THE cases of which I propose to speak are not strictly cases of acute epiphysitis, but cases of acute juxta-epiphyseal diaphysitis—that is to say, cases of acute osteomyelitis due to pyogenic organisms, and commencing in the soft vascular line where new bone is replacing cartilage, a line which is anatomically part of the diaphysis.

I have chosen this title because, in the first place, this group of cases forms a definite clinical entity quite distinct from the other groups of osteomyelitis, with which I do not intend to deal, and secondly, because acute juxta-epiphyseal diaphysitis, the only accurate name I know for the disease, is too much of a mouthful for everyday use. The term "osteomyelitis" is too vague, for, though it includes this group, it also includes many other conditions.

Acute pyogenic inflammation of the epiphysis itself is so rare that it may be neglected. In the ten years 1901 to 1910 (inclusive) there is, judging from the notes, only one case that might have started in the epiphysis (and this case is doubtful) out of 309 cases of acute epiphysitis. The term, then, though unscientific, is convenient, and in using it I am following the late Mr. Barnard,¹ who in 1903 read a paper under the title "The Relation of Trauma to Acute Epiphysitis."

CAUSATION.

The exciting cause is a pyogenic organism. The organism is usually *Staphylococcus aureus*. Trendel,² when dealing with osteomyelitis in general, found staphylococcus, streptococcus, and pneumococcus. In this series we find corresponding results, as follows:

Bacteriological Results in 49 Recent Cases.

	Cases.
Staphylococcus was found in	38
Type not stated " " " " " "	5
<i>Staphylococcus aureus</i> " " " " " "	28
<i>Staphylococcus citreus</i> " " " " " "	2
<i>Staphylococcus albus</i> " " " " " "	3
Streptococcus " " " " " "	7
Mixed streptococcus and staphylococcus was found in " " " " " "	2
Pneumococcus was found in " " " " " "	2

That is, 77 per cent. staphylococcal.

The organisms are carried to the bone by the blood stream. The route by which they reach the blood stream is somewhat debated. Thompson and Miles³ state that they may get in through septic sores, but that probably they are more often due to sore throats and other infections of the mucous membranes. Dolbey⁴ regards sore throats as the commonest source of entry of the organism.

I found a note of a possible source of infection in only 44 cases, but these 44 amounted to 79 per cent. of the cases where any note as to the presence or absence of a source of infection was made. In these cases a septic condition of the skin was by far the most common; there were 36 cases of septic foci in the skin, most of them septic sores, 1 a septic burn; 1 case, in an infant of 2 weeks old, was apparently due to umbilical sepsis; 1 was a boil on the neck, and another multiple superficial abscesses. The other foci found were 2 cases of whitlow, 3 of otorrhoea, and 6 of tonsillitis; but 3 of these latter had also skin sepsis.

It would appear, therefore, that the organisms usually reach the blood by the skin—a conclusion borne out by the predominance of staphylococci as the causative organisms, for if the tonsils were the common site of entrance streptococcal cases should predominate, for they are the organisms usually found in cases of septic tonsillitis. Again, if the intestinal mucosa be the site of

entry, why is the *B. coli communis* so rarely the causative organism? Moreover, acute epiphysitis is very much more common in the poorer classes than in the well-to-do. This is usually explained by saying that the better classes are better nourished; but the disease usually attacks healthy-looking, well-nourished children. The children of the better classes play, and are probably nearly as much exposed to injury as the children of the poor; so that the trauma will not, I think, explain this greater frequency in the poor. Septic sores are, however, very much rarer in the well-to-do classes, and, moreover, if children of this class have a more serious septic skin lesion they are so nursed and coddled that they run little risk of trauma, the great predisposing cause. This greater frequency of acute epiphysitis in the poor, then, may be regarded as confirmatory evidence that the source of infection is a septic skin lesion in the great majority of cases.

The first theory that occurs to explain why the organisms in the blood should settle in the juxta-epiphyseal region of a bone and set up acute inflammation there, is that the disease is due to a specific organism which has a predilection for newly formed bone. This view Dolbey⁴ adopted in 1906. It is, however, negated by the fact that several varieties of organism are found, varying presumably with the source of infection. It may be objected that in the cases where organisms other than *Staphylococcus aureus* are found the disease is atypical, and does not truly belong to this group. This is, however, not the case; for in all my streptococcal and pneumococcal cases the notes would lead one to suppose that the cases were quite typical and genuine. There remains one other possibility—that the staphylococci and streptococci are secondary infections, the real causative organism having so far eluded us.

If we examine the known etiological facts, we find as follows:

Sex.

The disease is more common in males than in females. Thompson and Miles³ give the proportion as 3 to 1. In the series under consideration there were 217 males and 92 females, or 7 to 3.

Age.

Trendel² and Moore⁵ state that more than half the cases occur between 13 and 17 years. In the cases here considered, 70 per cent. occur between 7 and 17. The age incidence is quite different in the two sexes, a point I shall have to speak of again in relation to trauma. It is often stated that in young infants the disease occurs chiefly in congenital syphilitics. I have, however, found little evidence that this is so, and take the view that congenital syphilis is a negligible factor in the etiology of this condition. Albee⁶ states that the scrofulous and rheumatic dispositions predispose. I have already stated that this is not true of the scrofulous, as the disease usually appears in healthy subjects, and here I am in agreement with Dolbey.⁴ With regard to the rheumatic disposition, I find that in only 3 cases out of 309 is a previous history of rheumatism given.

Trauma.

Trauma has long been recognized as the chief predisposing cause in this condition. I find that although only 30 per cent. of cases gave a history of trauma, if only those cases were taken in which a definite note was made as to trauma, 61 per cent. gave a history of trauma. Trauma of some slight degree is so common in children that the number of cases giving a history of trauma is largely a matter of chance. Nevertheless, that trauma is a very important predisposing cause is shown by the sex and age incidence of the disease.

If trauma be the cause of the greater frequency of the disease in males, as is generally stated, the difference in sex incidence should be nil up to 3 years old, up to which age both sexes are equally liable to trauma, and should become more marked as the cases grow older. This is so; for in ten years at this hospital there were 53 cases under 3 years of age, and of these 27 were males and 26 females. Again, boys are most liable to trauma between 7 and 17, and 70 per cent. of cases in them occurred between these ages. Whereas in girls, 69 per cent. of cases occurred before 10 years of age. So that in both sexes the disease is most common when trauma is most common.