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/ by G. Hunter Mackenzie.**

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INTUBATION OF THE LARYNX IN LARYNGEAL DIPHTHERIA,

WITH

NOTES OF FIFTEEN CASES.

BY

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INTUBATION OF THE LARYNX IN LARYNGEAL DIPHTHERIA.

THE operation of intubation of the larynx as now performed consists, as is well known, in the introduction *per vias naturales* of a metal tube so constructed that its upper extremity or head rests upon the ventricular bands and between the arytenoid cartilages, whilst its stem extends downwards through the glottis into the trachea. Any obstruction to the breathing located in the larynx will thus be cleared by the tube.

The operation appears to have been first performed by a French surgeon, but it is to Dr O'Dwyer of New York that credit is due for having established it on a practical basis. By careful experimentation and accurate measurements this investigator has succeeded in devising a set of instruments and a series of tubes appropriate to various ages, and it is with these instruments and tubes that the operations in the cases now to be recorded and commented on were performed.

In O'Dwyer's operation the child to be operated on is firmly enveloped in a blanket or sheet; he is then held by the nurse in the semi-erect position, with the head reclining on the left shoulder; a mouth-gag is then inserted on the left side, and firmly held, along with the child's head, by an assistant. The operator now selects the tube appropriate to the age of the patient, passes a thread through the eye in its head, attaches it by means of a screw in its pilot or obturator to the inserting instrument or applicator, and then, standing on the right side of the patient, endeavours, with the assistance and under the guidance of the left index finger passed through the mouth and hooking up the epiglottis, to insert it in the larynx. The insertor and obturator are now detached by means of a sliding arrangement in the handle of the applicator, and the tube alone is, or ought to be, left in the larynx. The operator now waits a few seconds, or possibly minutes, in order to decide whether the tube has been properly located in the larynx, or has been passed into the gullet. If successful, a beneficial effect on the respiration is almost immediately manifested,

and a peculiar metallic or clangy cough is developed, which, when once heard, cannot be mistaken. Should, however, the tube not have been properly placed in the larynx, as evidenced by the absence of the peculiar cough and of relief to the respiration, it must be withdrawn by making traction on the thread, and another attempt at insertion made. It may be here remarked that beginners usually require to make several attempts before succeeding. If the operation has been successful, the thread is either withdrawn, care being taken whilst doing so to steady the tube by the left index finger, or is left attached, in which case it may be taken across the cheek and fixed around the external ear. Whilst the maintenance of the thread adds to the irritation experienced by young patients, and aggravates the difficulty in swallowing by making traction on the epiglottis, it is probably better and safer for one who has not had much experience of the operation to allow it to remain attached, as by it the removal of the tube is greatly facilitated.

The length of time during which the tube ought to be left in the larynx varies somewhat with the nature and indications of each case; but, as a general rule, it may be said that it ought not to be allowed to remain longer than twenty-four hours without being withdrawn for purposes of examination and testing the respiration. If necessary, it can then be reinserted. To permit of removal, the patient is put in the position already described for the operation; the extractor is passed in the same manner as the applicator, and in such a way that its tapering extremity projects into the upper opening of the tube. A lever is then depressed by the right forefinger; this fixes extractor and tube, and both are withdrawn. If the thread has been left attached, the use of the extractor is not necessary, as simple traction will suffice to remove the tube.

In theory the operation is simple enough, and of easy performance, but in practice it will occasionally be found beset with some difficulties. These may be in connexion with insertion of the tube, with its dislodgment by coughing, with its blockage, with its interference with swallowing, and with its removal, more especially when the thread has been detached or been bitten through by the patient. A careful consideration of these difficulties and drawbacks, and more particularly of the advantages or disadvantages of the operation as compared with tracheotomy, is incumbent upon all; for there is no practitioner who may not at some time be suddenly brought face to face with a case of laryngeal diphtheria necessitating the performance of intubation or tracheotomy. The following notes of cases, with comments, are submitted as a contribution towards the solution of these important points:—

CASE I.—Girl, aged 8 years, 12th December 1888. The patient had been suffering for several days previously from what seemed at first to be acute tonsillitis, with considerable fever (E. T., 105°). The tonsils and adjoining parts of the pharynx were greatly swollen; on the 8th a patch of ulceration with membrane appeared on the right tonsil, which on the following day extended

to the left ; invasion of the larynx on the 10th ; urgent dyspnoea and intubation under chloroform on the 12th. The first two attempts were unsuccessful ; the third succeeded, but the thread attached to the tube having been caught by the insertor on its withdrawal, caused displacement of the tube. It was immediately and finally reinserted, and the thread withdrawn. The patient died twenty hours after intubation. The leading features after the operation were relief of the breathing, aggregation of mucus in the larynx or tube, and difficulty in its expectoration ; swallowing fairly satisfactory, with the occurrence of occasional spasm during the act, and marked failure of the pulse some hours before death.

This was the first case in which I performed intubation, and is the only one in which I administered an anæsthetic. After further experience I found that, with efficient assistance, it could be done very easily without anæsthetizing the patient. The second unsuccessful attempt to introduce the tube was due to the patient's head being placed too low, and to the tube becoming prematurely detached from the obturator, partly owing to faulty construction of the instruments. This case indicates the necessity of keeping clear of the thread on withdrawal of the insertor, otherwise displacement of the tube is bound to ensue. The relief to the breathing afforded by the operation in this case was not complete, and death resulted, partly from respiratory obstruction, and partly from cardiac and general exhaustion.

It may be added that the mother of the patient died during the following week of laryngeal diphtheria, for which tracheotomy was performed. On comparing the results of the respective operations in these two cases, I was inclined to think that intubation gave the greater relief, and was productive of the less discomfort.

CASE II.—Child, aged 21 months, 1st March 1889. I was asked by Dr P. A. Young to see this case, and if necessary to perform intubation. The child was reported to have been "croupy" for a day or two ; now there were marked laryngeal dyspnoea and stridor. No. 2 tube was introduced on the third attempt ; the breathing was immediately relieved, but inspiration was not so satisfactorily performed as one could have wished. The thread was not detached from the tube. The child was reported to have gone on fairly well until four hours after the operation, when sudden profuse hæmorrhage from the mouth and nose set in, and death immediately ensued. On inspection after death, the tube was found lying in the oro-pharynx, blocked with coagulated blood. Membrane was found in the larynx, and erosions of the left inferior (posterior) laryngeal artery and vein were found.

The fact of the tube being found in the oro-pharynx was due to the attempts of the nurse to remove it after death, by pulling on the thread. Regarding the hæmorrhage, if, as seems probable, this came from the eroded vessels, it must be regarded either as an incident of the disease or as a result of the operation. If the latter, it must have been from pressure of the lower extremity of the tube upon the vessels. On experimenting with the tube I found that, when *in situ*, its lower extremity did not correspond with the locality of the erosions, and I therefore came to the conclusion that the disease itself was the cause of the bleeding. The appearance of the erosions also favoured the idea of their being due to a

non-traumatic, ulcerative cause. Blocking of the tube by blood was doubtless the immediate cause of death in this case. If, as in this case, *sudden* accession of dyspnoea occur when the tube is in the larynx, it ought at once to be removed, examined, cleared of any obstruction that may be present, and reinserted, if necessary.

CASE III.—Boy, aged 3 years, 11th March 1889, under the care of Dr Hamilton Wylie. The child had been suffering from diphtheria of the pharynx for about a week. The disease had now extended to the larynx, as indicated by the signs of marked laryngeal obstruction; great restlessness was present. Intubation was followed by immediate and complete relief to the breathing. *14th March—Morning.*—The patient has breathed continuously well since the operation (three days); there is, however, a good deal of difficulty in swallowing, and the temperature keeps high (E. 105° , M. $104^{\circ}5$). The pulse is quick, regular; and weak. *Evening.*—The patient died at 8.30, after the supervention of great and sudden difficulty in breathing. An inspection was not permitted. The tube was found almost completely blocked with thick, glutinous, almost membranous material, which was removed with difficulty, even after maceration in hot water.

There can be little doubt that, in this case, the tube was permitted to remain too long in the larynx without removal for examination and cleansing purposes. It was my intention to have removed it in about twenty-four hours after the operation, but the breathing continued so satisfactory as to induce me to refrain from disturbing it, and let well alone. As in the preceding case, we have the child suffocated from blockage of the tube, an occurrence which I now think ought to happen very rarely, or not at all. The result was rendered all the more disappointing by the fact of the breathing having continued so good from immediately after the operation until just before death.

The high temperatures were partly due to a pulmonary complication (catarrhal pneumonia) which was present prior to the performance of the operation.

CASE IV.—Boy, aged 10 years, 31st March 1889, under the care of Drs McLeod and McEwan, Dundee. There was the usual history of progressive laryngeal stenosis, but the cause of this was at first somewhat obscure. Intubation was performed at 8 P.M., the tube being properly inserted on the first attempt. The breathing was immediately relieved, but did not become quite free until several hours after the operation. *1st April.*—P. 120, T. 103° ; the patient had passed a good night, and had swallowed very fairly indeed. He received some antipyrin, and was stimulated freely. *2nd April.*—The patient continued to progress satisfactorily; the pulse was better, and the temperature had fallen two degrees. He had nutrient enemata, and was still stimulated freely. At 7 P.M. the tube was removed. *3rd April.*—Temperature normal; breathing easy, and patient quite comfortable. He had passed a quiet night, and had slept well. *5th April.*—I was recalled to Dundee this afternoon, and found a relapse had occurred. The breathing was again obstructed, expiration being particularly prolonged and laboured. I again inserted the tube, which was twice expelled by severe attacks of coughing; very little relief to the breathing followed. The patient gradually sank, and died on the 7th, one week after the first intubation, with all the signs of obstructed respiration. On inspection of the larynx, etc., after death, firm diphtheritic membrane was found extending from the glottis through the trachea into the bronchi.

Nothing could have been more satisfactory than the progress of this case after the first operation. The downward extension of membrane to the bronchi, indicated during life by the peculiar laboured wheezy expiration, and by the auscultatory phenomena, accounted for the absence of relief after the second operation, and would have rendered equally nugatory any other surgical procedure, such as tracheotomy.

CASE V.—Boy, aged $4\frac{1}{2}$ years, 30th May 1889, under the care of Dr Henry Hay. Diphtheria of the pharynx and larynx, with great laryngeal obstruction. Intubation was performed. Some difficulty was experienced in getting the tube corresponding to his age properly located in the larynx, and it had ultimately to be withdrawn and a smaller one inserted. The tube was coughed up after having been in position for one hour; it was allowed to remain out for three hours, but the laryngeal dyspnoea having become more intense, the larger tube was again tried, without, however, appreciably affecting the breathing. The thread was left attached to facilitate removal of the tube should it again have been coughed out of the larynx. The child died four hours afterwards. Autopsy revealed diphtheritic membrane in the larynx, especially about the vocal cords, the epiglottis, and the infraglottic region. The tube could not be found in the larynx, pharynx, or mouth, but was discovered in the gullet, close to the stomach. As the result of a series of post-mortem experiments, it was found that the insertion of the tube in the larynx was not easy, principally on account of the membrane, which was very abundant about the *aditus laryngis*.

The leading feature in this case, apart from the general result, was the swallowing of the tube. The thread was left attached, for the reasons already stated, and was bitten through by the patient. The tube must either have been expelled from the larynx by coughing, or it must have been drawn out by traction on the thread. From one or other of these causes the tube changed from the larynx to the pharynx, and was swallowed. Similar cases have been recorded by other observers; in some of those the tubes were expelled *per anum*. From the fact that the patient swallowed milk with great ease during the last hour of life, I am inclined to suppose that the accident must have occurred shortly before death.

This case is that in which I experienced the greatest difficulty in inserting the tube appropriate to the age of the patient, and of this the abundant membrane at the entrance to the larynx was evidently the principal cause. I am now of opinion that it is a mistake to persist with intubation under such circumstances, and that recourse should rather be had to tracheotomy. Had this been done in the present instance, the locality of primary obstruction would have been cleared, and greater relief would consequently have been afforded to the patient.

CASE VI.—Child, aged 1 year, under the care of Dr Wylie, 28th October 1889. This child was reported to have been suffering for a few days previously from bronchitis, on which laryngitis with marked dyspnoea had supervened. Intubation was performed with ease, and great relief to the breathing at once ensued. Nine hours after the operation he was found breathing and swallow-

ing without difficulty; moist sounds had commenced to develop in the windpipe. He died fourteen hours after the operation, after having, according to the report of the family medical attendant, *breathed and swallowed without difficulty to the very end*. After death, the tube was found in the lower part of the trachea, and patches of membrane were found in the larynx.

So far as relief of the breathing was concerned, the operation in this case was successful. Death was due to one or other of those occult causes which are well known to affect children who are, or lately have been, suffering from diphtheria. The tube was forced into the trachea by unsuccessful attempts on the part of unskilled hands to use the extractor after death.

CASE VII.—Boy, aged $1\frac{1}{2}$ years, 6th December 1889. This child was reported to be suffering from "croup" (diphtheria of the larynx). He had had several severe laryngeal spasms; intubation was accordingly performed at 2 P.M., the tube being easily inserted on the first attempt. The breathing was immediately relieved, and became gradually easier as the day advanced. There was, however, considerable pyrexia (T. at 10 P.M., 105°); at the same time the child appeared to possess a fair amount of strength, and was breathing with great freedom. Wine was freely administered. 7th December.—The child died somewhat suddenly at 1 A.M., *without having again presented any symptoms of laryngeal obstruction*. An inspection was not permitted.

In the treatment of this case it was decided to rely mainly upon nourishment by enemata, an opinion having been expressed in some quarters (which I did not share), that food administered in the usual way was apt, with the tube *in situ*, to slip into the respiratory tract, and there cause trouble. The remarks appended to the preceding case apply equally to this. Here was another case in which the breathing was completely and permanently relieved by intubation, and yet the child died.

CASE VIII.—Boy, aged $7\frac{1}{2}$ years, under the care of Dr Wylie, 25th December 1890. An undoubted case of diphtheria of the pharynx, thence spreading to the larynx, with dry inspiratory dyspnoea, and suffocative spasms. Intubation was performed at 12 noon with some difficulty, but the tube was soon expelled by coughing. It was not re-inserted, as the patient now breathed with comparative freedom, and the respiratory sounds were moister. I did not again see the patient, in whom during the late afternoon laryngeal dyspnoea again developed. Re-insertion of the tube was not permitted by the relatives. He died at 9 P.M.

The difficulty in intubating in this case was owing to the presence of an abscess at the tip and under the nail of the operator's left index finger, which necessarily interfered with the power of guiding the tube into the larynx. The tube was not re-inserted immediately after expulsion on account of the ease to the breathing which had already ensued, and owing to the experience of some operators that a merely temporary insertion of the tube is sometimes sufficient to permanently relieve the breathing. Unfortunately in the present instance this did not prove the case.

CASE IX.—Boy, aged 6 years, under the care of Dr Brewis, 30th October 1890. Diphtheria of the pharynx and larynx, T. (8 P.M.) 104° . At 11 P.M. intubation was performed, with immediate and complete relief to the breathing,

the child becoming at once cheerful and playful. 31st October 1891.—9 A.M.—The night's report was that the child had swallowed easily; the breathing had continued unobstructed; marked collapse with high temperatures (104°–107° F.) had, however, ensued from about 6 A.M. The patient sank and died fourteen hours after the operation, without the re-establishment of the difficulty in breathing.

A more satisfactory immediate result after operation than was obtained here could not have been desired. The same fatal collapse with high temperatures which characterized cases VI. and VII. developed in this instance.

CASE X.—Girl, aged 2 years, under the care of Dr Henry Hay, 3rd February 1891. Diphtheria of the pharynx and larynx. At 11.30 P.M. the pulse could not be counted, and great inspiratory dyspnoea was present. Intubation was at once performed, with immediate and marked relief to the breathing and strengthening and slowing of the pulse. 4th February.—The child has breathed freely all day, and is apparently going on well. She had slept well during the night. Brandy is being freely administered, a moderate degree of difficulty in swallowing is present. 5th February.—The child continues to do well. At 4 P.M. I considered it advisable to remove the tube, which had been forty hours in the larynx, and this I tried to do with the assistance of the child's father. The process of gagging and the insertion of the extractor, along with some struggling on the part of the little patient, and some difficulty in locating the blades of the extractor inside the very small tube, appeared to completely exhaust the patient, and induced a condition of death-like collapse. Artificial respiration was immediately resorted to, and produced a partial revival only, for the child never returned to her former condition. She died a few hours afterwards, without a recurrence of the symptoms of obstructed respiration.

This case illustrates the difficulty and results that may follow, or be induced by, the manipulations necessary to remove the tube in very young children. The difficulty of a withdrawal in such cases frequently surpasses that encountered during the act of insertion, and some modification of O'Dwyer's method and instruments in this respect is urgently demanded. In this case, until the removal of the tube was set about, progress had been most satisfactory, and its rapid termination under the circumstances now described was a great disappointment.

CASE XI.—Boy, aged 5 years (nearly), under the care of Dr H. Wylie. Diphtheria, complicated with pneumonia of the left lung. The breathing was exceedingly difficult, the child, in fact, being apparently almost dead. The first tube inserted appeared rather small, for it was immediately expelled by coughing; the next larger size of tube was accordingly used. During the interval between the insertion of the two tubes, it was observed that the breathing was easier, with an abundant purulent expectoration. The breathing continued to improve after the insertion of the second tube, and the little patient went off in sleep, of which he had had very little for two nights previously. He was stimulated freely by brandy. 22nd February.—At 11.30 A.M., Resp. 56, T. 102° 5. Pulse quick but regular. Abundance of mucous râles were present in the throat (and tube?) He was reported to have swallowed very easily. The pneumonic lung was acting very imperfectly. 8 P.M.—Died without having evinced indications of marked respiratory obstruction.

This is another instance of death from other causes than respiratory obstruction.

CASE XII.—Boy, aged $4\frac{1}{2}$ years—22nd March 1891. This patient was believed to be suffering from bronchitis and simple laryngitis, but as shreds of membrane were subsequently coughed up, there can be no doubt that he was the subject of diphtheria. Intubation was performed at 2.30 P.M. The breathing was immediately relieved. At 9.30 P.M., the child meanwhile having breathed with tolerable ease, the tube was withdrawn, but required immediate re-insertion on account of the increase of dyspnoea which followed its withdrawal. 23rd March, 3 P.M.—Child doing fairly well, is breathing easily, and swallowing with the aid of a spoon. He is stimulated freely with brandy, port wine, and carbonate of ammonia. 10 P.M.—Cyanotic, with gurgling in windpipe (and tube ?) 11.30 P.M.—Died, with indications of obstructed respiration. An inspection was not permitted.

The causes of death in this case were the general exhaustion of the disease, and the probable fresh formation and extension downward of the membrane, as in Case IV.

CASE XIII.—Boy, aged $4\frac{1}{2}$ years, under the care of Dr Miller, Newhaven. 4th April 1891.—This boy was reported as having been apparently quite well until early in the morning of the 4th. At 10 P.M. his temperature was 103° F., pulse 150. Numerous coarse râles were audible in the windpipe; respiration was greatly embarrassed, expiration being rather more impeded than inspiration, and pulmonary complications were probably present. Paresis of sensation had developed. Intubation was performed at 11 P.M. under most unfavourable conditions; and although the breathing was relieved, the moist laryngeal râles still continued. There was great general collapse. The patient during the night was nourished by enemata, but he never rallied, and died at 5 A.M. on the following day. Shreds of diphtheritic membrane were found attached to the tube.

In this case the development of the disease was exceptionally rapid and intense, and the general collapse and prostration at the period of intubation, which continued to the end, were so marked as to render the case hopeless from the first. Death appeared to be due rather to the general than to the local conditions—probably to a combination of both.

CASE XIV.—Boy, aged 20 months, under the care of Dr Henry Hay. 6th April 1891.—The child was supposed to have burnt his throat in attempting to swallow a portion of a hot potato. On the day preceding this accident, however, he had been observed to be somewhat "croupy," and now there was commencing laryngeal dyspnoea. Intubation was accordingly performed at 10.30 P.M. No. 2 tube (O'Dwyer's scale) was first tried, but this proved too large, and could not be inserted into the larynx. No. 1 was therefore inserted. The breathing was markedly, but not entirely, relieved. 7th.—Has drunk freely of brandy and milk during the night without difficulty. The tube was withdrawn fifteen hours after insertion, and as the breathing thereafter continued good, it was not replaced. A shred of membrane was found attached to the tube. 10th.—The child now breathes freely, but is very weak. 12th.—Breathing all right, and the patient is apparently somewhat stronger.

This child recovered from the operation, but shortly afterwards became the subject of an unusual complication. On the 20th April I was again asked by Dr Hay to see the case. A large abscess had formed over the middle line of the larynx, and on the previous evening the child had coughed up some bloody pus. The abscess was opened, and a considerable quantity of putrid pus

escaped. The child died a few days afterwards, apparently of exhaustion. An inspection was not permitted.

In the absence of a post-mortem examination it is, of course, impossible to say with precision how the abscess had arisen. Its situation, the expectoration of bloody pus by the patient, and the septic condition of its contents, indicated that it communicated with the larynx. A diphtheritic ulcerative process of the laryngeal mucous membrane had probably extended to and implicated the cartilage, and thus led to perichondritis and suppuration in the overlying soft tissues.

CASE XV.—Boy, aged $6\frac{1}{2}$ years, under the care of Dr Henry Hay. 24th July 1891.—This child was extremely ill with “diphtheritic croup,” the dyspnoea, in fact, being so intense as to make death appear a matter of but a few minutes. Intubation was rapidly performed, with immediate and complete relief to the respiration. It is no exaggeration to say that the child breathed immediately after the operation as freely as if nothing were amiss with his throat. 25th July (twenty-four hours after intubation).—The child continues well, breathes freely, and swallows without difficulty. (Thirty-two hours after operation).—The dyspnoea has recommenced, the child is not so well, and is restless. (Thirty-six hours after operation).—The dyspnoea having increased, the tube was removed for purposes of examination, but it was found that the increasing difficulty in breathing was not due to its blockage. Improvement followed the removal of the tube, but only for a few minutes. The tube was accordingly reinserted, but no improvement in the respiration followed, and the child died of asphyxia shortly afterwards.

A second obstruction to the respiration, most probably due to fresh formation and extension of membrane to the trachea and bronchi, was the main and direct cause of death in this instance. It is highly problematical whether, under these circumstances, the performance of tracheotomy would have been of service; and as from the first the parents objected to this operation, it was not recommended in the latter stage of the case.

In commenting on the preceding cases, and in criticising in a general way the operation of intubation of the larynx, it is necessary to bear in mind that it is the application or performance of the operation in diphtheria with which we are now dealing. In non-diphtheritic affections in children, such as acute inflammation from scalds, etc., it is, as I have had occasion to note, a most excellent operation, yielding highly satisfactory results. Further consideration of these cases does not fall within the scope of the present paper.

Nor am I concerned to discuss the question of the identity or non-identity of croup and diphtheria, except to say that I am of those who believe what is sometimes called membranous croup to be diphtheria. No distinction, clinical or pathological, can be drawn between these two diseases (if two there be), and their mortality is, unfortunately, also equally great. Both are, in the words of Morell Mackenzie,¹ diseases “characterised by more or less inflammation of the mucous membrane of the pharynx, larynx,

¹ *Diseases of the Throat and Nose*, vol. i. p. 120.

or air-passages, and by the formation on the surface of these parts, especially on the mucous membrane of the fauces or windpipe, of a layer or layers of lymph, or false membrane, generally showing signs of bacteroid mycosis." It ought to be borne in mind, however, that the absence of false membrane does not preclude the existence of diphtheria. Morell Mackenzie¹ describes two classes of cases in which it may be absent—viz., "Those in which death from blood-poisoning occurs before the exudation has time to form, and those in which the local process is not severe enough to result in the formation of a definite membrane." This class has been described by Dr Michel Peter² as *diphtherite sine diphtheria*. I believe diphtheria without membrane to be a not uncommon disease.

The operation of intubation of the larynx may be considered in reference to—(1), Its Performance, embracing the Insertion, the Retention, and the Withdrawal of the Tube; (2), Its Technique and Instrumentation; (3), Its Adjuvants; and (4), Its Comparison with Tracheotomy.

1. THE PERFORMANCE OF THE OPERATION.

The details of O'Dwyer's method of operation have already been given in the early part of this paper, and now it is proposed to direct attention to some points of difficulty which are apt to be encountered, and some contingencies which may arise, in its performance.

The Insertion of the Tube.—Placing the tube in the gullet instead of in the larynx is a common occurrence, especially in the case of those who have not had much experience of the operation. If the operator will bear in mind to make the tube take a turn *forwards* after it has reached the epiglottis, it will, as a rule, slip easily into the larynx. If there is much membrane about the aditus laryngis, its passage into the larynx may be impeded (as in Case V.) Similarly, swelling of the supra-glottic portion of the larynx may altogether hinder the insertion of the tube, as in a case recorded by Menigan,³ in which, on account of the swollen ary-epiglottic folds, the tube could not be placed so as to be retained, and laryngotomy was accordingly necessary. Repeated attempts to insert may exhaust, and even kill, the child. O'Dwyer⁴ affirms that apnoea may result from prolonged efforts at introduction. One of the most untoward results of insertion is detaching and pushing membrane into the trachea, and so causing more or less complete obstruction. I am not conscious of having witnessed this accident, but Barlow⁵ mentions having met with it once, with

¹ *Op. cit.*, p. 141.

² *Thèse de Paris*, No. 270, Paris, 1859 (quoted by M. Mackenzie).

³ *New York Medical Record*, 6th October 1888.

⁴ *Ibid.*, 10th October 1887.

⁵ *Lancet*, 20th September 1890.

a fatal result. O'Dwyer¹ acknowledges that it may occur, and says it is more likely to happen in secondary dyspnoea when the tube is introduced for the second time. In one case where this happened the tube was immediately withdrawn, when a membranous cast of the trachea was coughed up. In all such cases it is necessary to remove the tube and afford the patient an opportunity of expelling the detached membrane. Failing this, tracheotomy or a rapid laryngotomy may be indicated.

The Retention of the Tube.—In two of the cases reported in this paper death was due to asphyxia from blockage of the tube—in the one case by blood, and in the other by inspissated mucus. Such occurrences do not appear to be common. Deming² has recorded a similar case, and O'Dwyer,³ out of sixty-five cases, found that in two the tube was stopped with membranous masses, but apparently without fatal results. Wheeler⁴ mentions the case of a child who, twelve hours after intubation, had a severe fit of coughing and died suddenly. The tube was found completely obstructed with a large piece of false membrane, which had apparently been driven into it by the act of coughing. Mount Bleyer⁵ found that, in two out of 322 cases of intubation which terminated fatally, the cause of death was asphyxia due to closure of the tube by membrane. It is curious to note the divergence of opinion which exists regarding this very important point—the liability of the tube to blockage. Ramon de la Sota⁶ speaks of it as being a common accident; whilst Fletcher Ingals⁷ says that the incidents of the clogging of the tube and choking are so rare as not to trouble him. The writer seems to have been somewhat unfortunate in having met with it twice in fifteen cases.

To obviate the risk of blockage, it is advisable to remove the tube every twenty-four hours, inspect, and, if necessary, clean it. Pinkham⁸ recommends to clear the tube in position by means of an aspirator—a most impracticable suggestion. It is stated by some authorities (Fletcher Ingals⁹) that when the tube becomes clogged it is almost certain to be coughed up, but this has not been my experience. This occurrence ought not to be depended upon as at all likely to happen.

Coughing up of the tube is a much more common, and fortunately a much less serious event than blockage. It repeatedly occurred in several of my cases, without having any bad result. The tube is either forced into the oro-pharynx or mouth, whence it can easily be removed by the finger. It may be swallowed

¹ *New York Medical Record*, 22nd October 1887.

² *Ibid.*, 18th February 1888.

³ *Ibid.*, 28th May 1887.

⁴ *Ibid.*, 26th February 1887.

⁵ *Transactions of the Tenth International Medical Congress*, 1890 (reprint).

⁶ *Siglo Medico*, 12th October 1890.

⁷ *Transactions of the Ninth Annual Congress of the American Laryngological Association*, May 1887.

⁸ *New York Medical Record*, 17th March 1883.

⁹ *Op. cit.*

(Case V.) Tipton¹ mentions a case in which the tube was swallowed and passed per anum, and Ramon de la Sota² had a child who passed the tube per anum after several days. In such cases it will usually be found that too small a tube has been used.

I have not witnessed any injurious local effects from the continued presence of the tube in the larynx, but other observers claim to have done so. Shingleton Smith and Waldo,³ in a case of intubation, ascribe an attack of acute inflammation of the larynx and trachea to the presence of the tube. Northrup⁴ found in five out of twenty intubations deep ulcers laying bare the tracheal rings. The head of the tube did not cause ulceration, but at most only a necrosis of the epithelium. It seems to be the anterior wall of the trachea which is most apt to suffer (Boldt and Northrup⁵). It is pointed out by O'Dwyer⁶ that the subglottic portion of the larynx is the narrowest portion of the upper air-passages, and here, in croup, necrosis of the mucous membrane may take place in twenty-four hours. In eighteen out of seventy-two fatal cases Bokai⁷ found that the tube had caused ulceration, but in sixteen it was slight. In one case there was a perichondritic tracheal abscess, in the other also the cartilage was involved. Widerhofer⁸ has seen cases of decubitus (pressure ulceration) from intubation; and Mount Bleyer⁹ found, out of 512 cases, that ulceration from pressure occurred in 1 per cent. It is difficult to gauge the value of these statistics, as, in the absence of necropsies, it is virtually impossible, in the great majority of cases, to say whether ulceration has or has not been produced by the tube. It does not appear to produce serious results, unless such cases as those reported by Chavasse¹⁰ (that of a five year old boy, in whom, after diphtheria and intubation, a complete stenosis of the larynx existed) and by Widerhofer¹¹ (who says he has seen instances of cicatricial stenosis necessitating tracheotomy follow intubation) be due to the formation and subsequent healing of pressure ulcers. The possibility, however remote, of these local lesions is an additional reason why the tube should be removed at the earliest possible moment, and is a partial justification for the practice of what Huber¹² calls "intermittent intubation," in which a smaller canula which can be easily coughed out is employed, and is not reinserted until the respiratory obstruction becomes marked.

¹ *New York Medical Record*, 22nd October 1887.

² *Rev. Méd. de Sevilla*, tom. xii. No. 12.

³ *Lancet*, 18th June 1887.

⁴ *Philadelphia Medical News*, 11th June 1887.

⁵ *New York Medical Record*, 12th November 1887.

⁶ *Ibid.*, 5th October 1889.

⁷ *Jahr. f. Kinderheilkunde*, Bd. xxxiii. H. 3 (Epitome of *British Medical Journal*, 12th March 1892).

⁸ *Naturforscher Versammlung in Bremen*, 1890.

⁹ *Transactions of the International Medical Congress*, 1890 (reprint).

¹⁰ *British Medical Journal*, 23rd November 1889.

¹¹ *Op. cit.*

¹² *Arch. of Pediatrics*, January 1889.

Continuous pressure of the tube on one particular spot would thus be averted.

The Withdrawal of the Tube.—The period of permanent withdrawal of the tube varies considerably in different cases. Curtis¹ records the case of a ten year old child with diphtheria, in whom the tube along with some pieces of membrane were expelled by coughing twenty minutes after insertion. Secondary intubation was not necessary, and the child recovered. Brothers² describes what is probably the case in which the tube was borne for the longest time on record, viz., fifty-eight days, with interruptions to the end of the twenty-first day. As a general rule, an attempt ought to be made every twenty-four hours to do without the tube: if dyspnoea return, it ought to be reinserted. Spasm of the glottis occasionally follows on its removal (Cheatham³); this is successfully treated by the inhalation of chloroform for fifteen or twenty minutes. Partial or complete aphonia, but only lasting for a day or two, and spontaneously disappearing, is occasionally a sequel (Mount Bleyer⁴).

2. TECHNIQUE AND INSTRUMENTATION.

Tubage of the larynx appears to have been first accidentally demonstrated in 1801 by Desault,⁵ but intubation, as now practised for the relief of croup and diphtheria, was first employed, though merely experimentally, by Bouchut of Paris, in 1857. In 1880 O'Dwyer began his course of experimentation, and in the course of the next few years elaborated the method and devised the instruments which are now known by his name.

These instruments are ingeniously adapted for the purpose primarily in view,—the locating, *per vias naturales*, of a tube in the larynx. To the casual observer the tubes seem of small calibre, and hardly efficient for the maintenance of effective respiration. But, as pointed out by O'Dwyer,⁶ the smallness in calibre of the tube renders expectoration and coughing more easy, and he recommends⁷ that small tubes be employed more particularly in those cases where there is a suspicion of membranous masses in the trachea, as they are more likely to be expelled by coughing. Shorter tubes with a much wider calibre have, however, been more recently used by O'Dwyer.⁸ I have repeatedly seen

¹ *Lancet*, 31st March 1888.

² *New York Medical Record*, 27th July 1889.

³ *Cincinnati Lancet Clinic*, 10th February 1888.

⁴ *Transactions of the Tenth International Medical Congress*, 1890 (reprint).

⁵ For a full history of intubation and tracheotomy see paper on "Intubation or Tracheotomy," by Dr Max. J. Stern, *Transactions of the Ninth International Medical Congress* (Section of Laryngology), 1890.

⁶ *New York Medical Journal*, No. xvii., 26.

⁷ *New York Medical Record*, 22nd October 1887.

⁸ *Ibid.*, 21st December 1889.

that respiration can be very effectually performed by the medium of the smaller tubes. The obturator with which each tube is fitted requires frequent careful examination, as a case has been recorded by Eichberg¹ in which it broke and stuck in the tube, and rendered tracheotomy necessary.

The instrumentation connected with removal of the tube seems in urgent need of modification. It is no easy matter to at once insert the extractor into the upper orifice of the tube, especially in the case of very young children, and any delay or bungling increases the already great exhaustion, and may even lead to a fatal result (Case X.) True, removal may be facilitated by pressing upon the exterior of the larynx in an upward direction with the left hand, whilst the right forefinger is used to remove the tube, or even by inverting the child, as has frequently been successfully done in the cases of foreign bodies in the larynx. O'Dwyer² acknowledges that the larynx may be wounded in the removal of the tube, by failing to get the extractor into the orifice, and pushing it down by its outer side, and he has modified the heads of the larger tubes which he has more recently introduced, so that they can be withdrawn with the finger-nail.³ I have not made trial of these modified tubes. Around the neck of the ordinary tubes I have had applied an india-rubber band or collar, with an erect projection anteriorly resembling an artificial epiglottis. This has not been done with the view of aiding the epiglottis in its functions, as proposed and carried out by Waxham,⁴ but with the object of allowing the tube to be more easily withdrawn. With his left forefinger the surgeon feels the tip of the artificial epiglottis and guides the slightly curved forceps—which should open not laterally, but antero-posteriorly—introduced with the other hand; the rubber epiglottis is then easily seized and the tube withdrawn. The manipulation is easy, and is unaccompanied by any of the risks which undoubtedly accompany the use of O'Dwyer's ordinary extractor.

In case of mishap during or immediately after intubation the operator ought always to be prepared to perform tracheotomy, and, as recommended by Waxham,⁵ he ought to be provided with a pair of long tracheal (or laryngeal) forceps, which might prove useful in assisting to clear the windpipe.

Though not an absolutely essential preliminary of the operation, the question of gagging in intubation is one which merits some consideration. I believe that on some occasions I have witnessed severe dyspnoea distinctly augmented by the introduction and opening of the gag, and I observe that the reviewer of a recent

¹ *Cincinnati Lancet Clinic*, 15th November 1890.

² *New York Medical Record*, 22nd October 1887.

³ *Ibid.*, 5th October 1889.

⁴ *Medical Age*, Detroit 10th April 1888.

⁵ *Philadelphia Medical News*, 1st January 1887.

work on *Intubation of the Larynx*¹ affirms, "that occasionally a young child dies outright in consequence of the gagging, and that, short of dying, the dyspnoea in many is seriously increased by the gag." The gag ought to be used with great care, and in cases of severe dyspnoea it may be advisable to dispense altogether with its use, and intubate under general anaesthesia.

3. ADJUVANTS.

The lull which ensues after a tube has been properly placed in the larynx, and the ease in breathing which characterizes it, are unfortunately frequently of a merely temporary and illusory nature. The little patient not unusually progresses favourably during the first twenty-four hours, and it is only after the expiry of that period, or even as late as the sixth day (Case IV.), that exhaustion begins to tell, fresh membrane forms and extends downwards, and pulmonary and other complications develop. Consequently it is as much upon the after-treatment and management of these cases as on the successful performance of intubation that the final issue depends, and unless this be borne in mind and put in practice, neither intubation nor any other operation which the wit of the surgeon can devise will be of much avail in diphtheria. Waxham,² who has had a very large experience of intubation, attributes his increasingly favourable results to the adoption of better systems of after-treatment, especially of nourishment. This after-treatment may be considered from the dietetic and the medicinal points of view.

Dietetic.—The difficulty in feeding the patient is often advanced as one of the objections to intubation. There can be no doubt that the presence of a metallic tube must necessarily impede the movements necessary to the perfect closure of the larynx during deglutition. Various attempts have been made to overcome this difficulty, as by Mount Bleyer,³ who has introduced what he calls a self-closing intubation tube made partly of hard and partly of soft rubber. The head and neck being soft permit of compression, and consequently of closure of the tube being effectively carried out during the deglutitory act. But with a little attention to the method of feeding it will be found that it can be effectively carried out with the metallic tube in position. We are sometimes told that semi-fluids and not fluids ought to be given; but this cannot be carried out in practice, especially in the case of young, feverish, and thirsty children, who insist upon being permitted to drink. The position best adapted for swallowing is that described

¹ "Intubation of the Larynx," by James B. Ball, M.D., *British Medical Journal*, 18th July 1891.

² *New York Medical Record*, 29th June 1889.

³ *Journal of the Respiratory Organs*, August 1889.

by Casselberry,¹ "by position, head downwards, on an inclined plane. An angle of inclination of 20° is suitable for most cases." Some authorities recommend a position with even a greater angle of inclination, but the objection to this is an occasional tendency for the tube to slip out of the larynx. I can confirm the value of allowing a slight declination of the head, especially if the patient at the same time is induced to take fluids through a tube, or through the spout of a drinking-cup. Care should be taken to prevent the patient taking inordinate quantities of fluid. In five cases Mount Bleyer² saw death result from mechanical obstruction of the heart caused by distension of the stomach from fluids.

Some authorities write of "aspiration pneumonia" as being a not infrequent result of attempts at swallowing with the tube in position. Denison³ affirms that in nine out of eighteen fatal cases in his practice death ensued from this cause, whilst Rosenberg,⁴ two years afterwards, says that pneumonia from swallowing has not yet been observed. Fletcher Ingals⁵ believes that the great percentage of deaths is due to the entrance into the lungs of foreign substances (pneumonia). As, however, the great majority of writers, mainly American, on this subject make no mention of the occurrence of this form of pneumonia, I conclude that it cannot be so common as the above-mentioned authors declare. I am not conscious of having witnessed its occurrence. To minimize the risk of its occurrence feeding by the stomach-tube is recommended by some writers.

The quality and quantity of food to be administered after intubation is rather a general than a special point, and must be determined by each practitioner for himself. The great importance of attending carefully to nourishment cannot be over-estimated. Of course, if the practitioner thinks it desirable, there is no reason why supplemental rectal alimentation should not be had recourse to, and, as a matter of fact, this is frequently done.

Medicinal.—In considering the medicinal after-treatment of intubation cases it is not my intention to discuss the treatment of diphtheria, or to even enumerate the many diverse remedies which from time to time have been advanced for its cure—remedies which range from salts of gold to tobacco juice.⁶ The apparent success which attends the use of each remedy would be wonderful, did we not bear in mind, as naïvely remarked by Hildebrandt,⁷ that there are forms of diphtheria which yield to every remedy,

¹ { *Journal of the American Medical Association*, 24th August 1889.

{ *Chicago Medical Journal and Examiner*, October 1888.

² *Transactions of the Tenth International Congress*, 1890 (Reprint).

³ *Transactions of the American Medical Association*, June 1889.

⁴ *Berliner med. Gesellschaft*, 11th and 12th March 1891.

⁵ *Journal of the American Medical Association*, 10th July 1886.

⁶ *Semaine méd.*, 10th December 1890. Schwitzer recommends pencilling with extract of tobacco juice, and gargling with a decoction of tobacco leaves.

⁷ *Münch. med. Wochen.*, Nos. 18, 19, and 20, 1891.

and others in which every remedy fails. For reasons which need not now be discussed, the worst forms of diphtheria are those in which the larynx is affected, *i.e.*, precisely those in which we are called upon to intubate, and I agree with Dillon Brown¹ in the conclusions he arrived at after an experience of 200 cases, that those in which membrane is absent from the pharynx or posterior nares are more fatal than those in which membrane is present in those localities.

In the medicinal treatment of post-intubation cases, one of the most important points is that of stimulation. Should alcohol be administered, and if so, how? Different opinions have been expressed on this point. Jacobi of New York, whose experience of diphtheria in children has been very large, says,² "Alcoholic stimulants ought to be given early and freely. A few ounces daily may suffice, but the author has often seen ten ounces daily of brandy or whisky save children who had been doing badly with three or four. There is no danger of intoxication from them in such septic diseases as diphtheria." These views were expressed with reference to the general treatment of the disease, but I believe they are also applicable to those special cases in whom intubation has been performed.

The frequent subsequent collapse of patients who have borne the operation well, and in whom respiration is effectively performed until the very end, indicates that active medical treatment is urgently called for. Heart failure, which may develop with or without warning, is probably the affection which most clamantly demands attention. "Cardiac stimulants," says Jacobi,³ "are indicated, and their administration ought not to be postponed until feebleness and collapse have set in." Digitalis, preferably in combination with iron, ought to be frequently administered in doses proportionate to the age of the child, and all depressants, such as emetics, and drugs such as antipyrin, ought to be avoided. In several of the cases recorded in this paper mercurial inunction was practised, but without, so far as could be seen, affecting the progress of the case.⁴

The amount of purely local treatment necessary after intubation should, I think, be small. A bi-hourly spray of peroxide of hydrogen,⁵ of the strength of 10 to 15 volumes mixed with two or three times its bulk of water, from its antiseptic and

¹ *New York Medical Journal*, 9th March 1889.

² *British Medical Journal*, 22nd September 1888.

³ *Deutsche med. Zeitung*, No. 72, 1890.

⁴ *Op. cit.*

⁵ It is right to record that O'Dwyer ascribes his increasingly favourable results partly to the use of the sublimate (*New York Medical Journal*, 14th January 1888).

⁶ Peroxide of hydrogen is now kept in stock by most chemists. It is well preserved by keeping in a cool place, at a temperature not exceeding 65° F. and excluding the light. Metals should not be used in its application.

unirritating nature, and its freedom from inducing toxic symptoms, appears to be the local remedy which, especially in America, has met with most favour. This remedy may also be applied by irrigation, by means of a catheter, which may be passed right into the larynx. It may be here mentioned that sprays and inhalations are more efficacious when used through the nose than through the mouth, and in this manner the peroxide ought to be more particularly employed. Mercurial washes and sprays and applications of lime-water may act chemically upon the tube (Boldt and Northrup).¹

The shutting-up of these cases in "croup-tents" in an atmosphere of steam appears a very doubtful procedure, and I regret that in several of the cases now recorded this was had recourse to. Acute laryngeal diphtheria in children is almost invariably characterized by a high temperature, *i.e.*, 102° and over, and the only results I have witnessed of this method of treatment have been augmentation of the fever and of the restlessness of the child, and an increased disinclination for food. The moistening of the throat, as already stated, can be effectually carried out by means of the peroxide of hydrogen spray or douche. I am in favour of placing such patients in cool, well-ventilated rooms, without steaming.

COMPARISON WITH TRACHEOTOMY.

The mortality of the two operations may be first compared. Out of 2166 cases of intubation of the larynx in croup or diphtheria, which I have collected from various sources, 32·5 per cent. recovered; similarly, out of 1730 cases of tracheotomy, 22 per cent. recovered. The difference is thus about 10 per cent. in favour of intubation.

Dillon Brown,² in March 1889, published a list of 2368 cases of intubation obtained from the records of 166 operators, with 27·3 per cent. of recoveries. The mortality of intubation in the practice of any one operator tends to diminish as he acquires increased experience, and, above all, recognises the necessity of paying most careful attention to the details of after-treatment. This is well shown by Waxham³ in the following figures from his practice:—

1st	100	cases	gave	27	per cent.	of recoveries.
2nd	100	"	"	34	"	"
3rd	100	"	"	42	"	"
Last	43	"	"	41·85	"	"

It is advanced in favour of intubation that it is bloodless, can be performed with great rapidity, and does not preclude the subsequent performance of tracheotomy. The first two are correct

¹ *New York Medical Record*, 12th November 1887.

² *Ibid.*, 9th March 1889.

³ *Archives of Pediatrics*, July 1891.

enough, the latter only partially so. If the operation of intubation miscarry, recourse may be had there and then to tracheotomy with advantage; but if this be deferred until the tube has been in position for twenty-four hours or longer, the results seem somewhat disastrous. This is hardly surprising when consideration is given to the conditions under which a deferred tracheotomy is performed, the most common being a downward extension of the membrane into the trachea and bronchi. Ganghofner¹ records 42 cases of intubation, with 21 late tracheotomies, all of whom died; and Urban² had 32 intubations with 18 subsequent tracheotomies, all fatal. On the other hand, Guyer³ found that tracheotomized children who were deprived of their tube with difficulty, as frequently happens, were afterwards beneficially intubated.

It is in favour of tracheotomy that the opening in the windpipe permits of its frequent examination and cleansing. For now-a-days one hardly requires to be told that the opening in the windpipe should not be looked upon as simply permitting an entrance for the canula, but also as affording to the practitioner a means of access to the interior of the trachea for cleansing and medicative purposes, of which he should constantly avail himself.

In America, the land of its birth, and where records of hundreds of cases by individual surgeons are not uncommon, O'Dwyer's method of intubation is regarded with a considerable amount of favour. In this country, however, where it is much less frequently performed, and has hardly emerged from the experimental stage, it has not met with the same degree of acceptance, and must be considered still *sub judice*.

¹ *Jahrbuch für Kinderheilkunde*, xxx. 3, 1889.

² *Deutsch. Zeitschrift für Chirurgie*, 31, 1890.

³ *Corresp. Blat. für schweizer Aertze*, No. 13, 1889.

