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INTUBATION OF THE LARYNX

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INTUBATION OF THE LARYNX

BY

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WITH ILLUSTRATIONS

LONDON
H. K. LEWIS, 136 GOWER STREET, W.C.
1891

UNIVERSITY
OF BRISTOL
MEDICINE

PREFACE.

THE following pages are mainly a reprint of a paper which the author contributed to the 'Illustrated Medical News' in 1889. Some additions have been made, and further statistics of the results of intubation have been introduced. It is hoped that this little book may be useful to those who are not already familiar with the operation, and who are anxious to give it a trial.

WIMPOLE STREET;
May, 1891.

CONTENTS.

INTUBATION OF THE LARYNX.

I.

CATHETERISM AND INTUBATION OF THE LARYNX.

For many years the passage of tubes through the glottis has been had recourse to, for different purposes. The term catheterism or catheterisation of the larynx has been generally applied to the introduction into the air passages of a long tube, the upper end of which projects from the mouth or nose. The term intubation or tubage, on the other hand, has been applied to the method by which a small tube is placed in the larynx, the upper end of which rests below the epiglottis; and the term is now more particularly used to designate the method introduced, a few years since, by Dr. Joseph O'Dwyer, of New York.

Probably the first purpose for which the passage of tubes into the larynx came into use was for insufflation of air into the lungs of asphyxiated or partially drowned persons. Towards the latter part of the last century, Fine, of Geneva, Desgranges, Goodwyn, James Curry, and others, used laryngeal tubes for insufflating air into the lungs of persons rescued from drowning. About the end of the century Chaussier designed a canula which he introduced into the larynx of infants born without signs of life, and through which he insufflated air into the lungs. Chaussier's tube continued to be much used in

France for the same purpose, and modifications in its form were devised by Leroy d'Etiolles (1829), Depaul (1845), and others.

Another purpose for which laryngeal tubes have been used has been the introduction of caustics or other medicaments into the air passages. Thus Girouard, in 1827, advocated the passage of a tube through the glottis in croup, and the application by this means of caustics to the larynx. Dieffenbach, of Berlin, in 1839 endeavoured to produce favourable results in croup by the application of caustics through a bent canula inserted into the larynx, guided thither by the left index-finger, which he passed behind the epiglottis. He used a metal ring to protect the index-finger from being bitten. Horace Green, of New York (1855), advocated the topical application of solutions of nitrate of silver or other medicaments, in chronic lung disease, by means of a long bent gum-elastic tube or a probang, which he introduced into the trachea, and which he professed to be able to pass into either bronchus. Loiseau, of Paris (1857), treated cases of croup and diphtheria by introducing into the larynx a bent silver tube, through which fluids were injected, or a sound was passed, armed with solid caustic, or with a sponge soaked with liquid. Like Dieffenbach, he used a metal ring to protect the left index-finger and keep the teeth apart.

The most important purpose, however, for which tubes were passed into the larynx, and the one which has the most direct bearing on the present subject, was with a view to leave the tube *in situ* a considerable time, so as to enable respiration to be carried on, in cases of dyspnœa from any obstructive disease of the larynx.

It is recorded of the celebrated French surgeon Desault, by his pupil Xavier Bichat,* that he had long suspected that the extreme sensibility of the larynx and trachea

* 'Œuvres Chirurgicales, ou Exposé de la Doctrine et de la Pratique de P. J. Desault,' par Xavier Bichat, 3me édition, Paris, 1813, vol. ii, p. 266.

would soon become deadened, and the surface become habituated to any smooth body which was kept in contact with it. An accident threw in his way the proof that this notion was correct. On a patient suffering from cut throat, Desault passed an œsophageal bougie for the purpose of feeding. The introduction of the tube excited spasmodic cough, which soon subsided. After an hour a little bouillon was being injected, but the attempt excited violent cough. The patient was left a couple of hours before the attempt was renewed, but the injection of a few drops again excited violent cough. Desault then suspected that the tube was in the trachea, and the current of air which was found proceeding from it showed this to be the case. The tube was removed and reintroduced, this time into the stomach, and the food was injected without trouble.

The date of this observation is not given. It is doubtful when Desault first profited by it, but it seems probable that it was about the year 1793, that is, two years before his death. Bichat mentions four cases in all, in which Desault employed catheterism of the larynx. One was that of a patient suffering from *angine tracheale*, in whom tracheotomy was about to be performed for symptoms of impending suffocation. Desault, however, passed an elastic tube into the larynx and trachea. Sharp pain and cough followed, but soon abated. The respiration became easy, but the fever got more severe, and the patient died during the following night.

Another case was that of a man suffering from acute inflammatory sore throat, with difficulty of breathing. Desault passed a flexible tube into the trachea, and after the cough and irritation had subsided the breathing became easy. At the end of twenty-four hours the breathing was impeded, and the tube was removed, cleaned, and reintroduced. The breathing continued free, and in another day and a half the tube was removed, being no longer needed.

A third case was that of a madman with cut throat.

The trachea was severed in its anterior two thirds, about an inch below the cricoid. Violent dyspnœa followed the inclined position of the head which was necessary to adjust the edges of the wound. Desault introduced by the nose a gum-elastic tube into the larynx and trachea; violent cough followed, but soon calmed down; respiration went on freely, and the edges of the wound were brought together without inconvenience to the patient. The tube remained in several hours, but during the night the patient tore his wound open and died of hæmorrhage.

A fourth case is mentioned by Bichat similar to the preceding case, of which, however, he had no details, except that it was one of cut throat, that the tube was inserted in the same way, and that complete recovery followed.

Bichat states that other surgeons employed the same method, after Desault's example, and obtained similar results. He briefly alludes to two such instances. One was that of a Toulouse surgeon, who employed the method in some chronic throat affection, attended with dyspnœa. There was a good deal of trouble owing to the tube getting clogged, and the patient was ultimately lost sight of. The other was that of a soldier in the Lyons Hospital, with cut throat. He was fed and enabled to breathe for fifteen days, with the aid of two tubes, one being introduced into the larynx, the other into the œsophagus.

Desault appears to have used a large-sized gum-elastic catheter, with two large eyes and an opening inferiorly, and he introduced it through one or other nasal fossa rather than by the mouth.

It would thus appear that by the close of the last century catheterism of the larynx for the relief of dyspnœa was in a fair way of becoming, in France at all events, a well-established method of procedure. It seems, however, to have fallen into disuse, and subsequent operators, in many cases, appear to have been unaware of Desault's observations.

In 1844 two cases of catheterism of the larynx for the relief of dyspnœa were published by Lallemand, of Montpellier. In 1855 Reybard read a paper, at the French Academy of Medicine, on catheterism of the larynx in croup. He speaks of it as a method of relieving the dyspnœa, not employed, yet quite simple. He used a gum-elastic catheter with two large eyes, and either left it in place or introduced it from time to time. He cites no cases.

In 1858 Bouchut read a paper at the French Academy of Medicine, entitled *D'une Nouvelle Méthode de Traitement de Croup par le Tubage du Larynx.** The method consisted essentially of placing in the glottis a small tube by which respiration could be carried on. Bouchut's operation possesses a special interest as being the first attempt at intubation proper, as distinguished from catheterism. In a subsequent discussion on his paper he insisted on the distinction between his method and catheterism. The latter operation, he stated, he had himself successfully adopted in a case of acute laryngeal dyspnœa, several years previously.

The instruments employed by Bouchut, which were figured in the journals of the day, and illustrations of which are reproduced (Fig. 1), consisted of a straight cylindrical silver tube, 1½ to 2 centimetres long, and 7 millimetres in diameter, but narrower at the lower end than the upper; the upper end was provided with two circular prominences, placed 6 millimetres apart, between which the vocal cords rested when in position; the upper edge was pierced with a hole for the attachment of a silk thread, which was brought out at the mouth, and was intended to prevent the tube going down the trachea or œsophagus, and to enable it to be taken out when necessary; a curved sound, open at each end, which served for the introduction of the tube into the larynx; a metal ring to protect the index-finger and keep the teeth apart.

* 'Bulletin de l'Académie,' vol. xxiii, p. 1160.

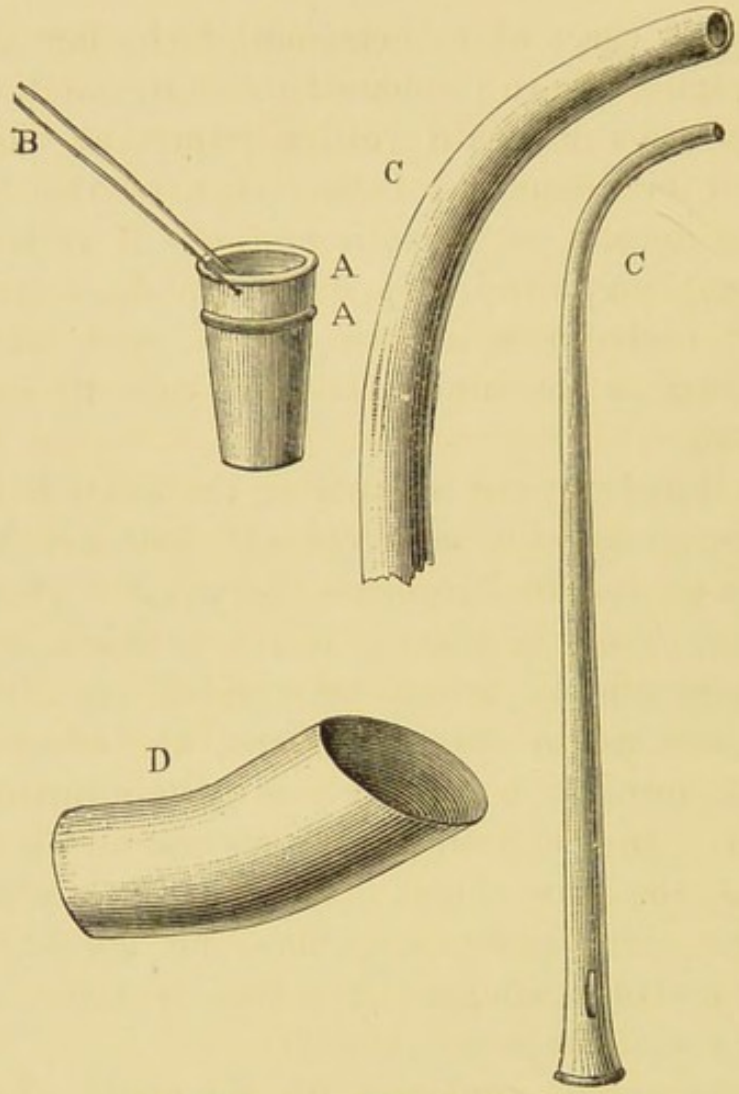

FIG. 1.—Bouchut's Instruments.

A A. The tube. B. The thread. C C. Sound for introducing the tube. D. Metal ring for protecting the finger.

Bouchut* further devised an instrument which he termed a *raclette*, for scraping the mucous membrane of the trachea in order to detach the false membrane and facilitate its removal. It was intended to be introduced through the intraglottic tube.

The actual results of Bouchut's cases were not exactly satisfactory, for of the seven which were reported to the Academy of Medicine five died, and the two that ultimately recovered only did so after tracheotomy had been performed. Bouchut, however, considered that his cases proved (1) the facility of practising tubage with a canula

* 'Gazette des Hôpitaux,' September 24th, 1858, p. 673.

fixed between the vocal cords, and not interfering with the epiglottis; (2) the tolerance of the larynx for the canula; (3) the possibility of relieving the dyspnœa of croup and other diseases of the larynx by this method; (4) the facility of membrane finding exit from the trachea by the intraglottic tube; (5) the utility of the method to doctors who, living in remote places, and far from all assistance, could use this method in place of tracheotomy.

Trousseau, who reported for the commission appointed to inquire into Bouchut's method, admitted that tubage of the larynx had in no case produced death, or even accelerated it, and that in some cases it had even seemed to retard it. The commission did not think that tubage of the larynx should be entirely rejected. It might be perfected, and would then doubtless have to record some positive successes. In spite of this by no means unfavourable report, Bouchut does not appear to have pursued his method farther, or to have attempted any improvement. According to a paper which he read in 1887 at the Washington International Congress, however, he does, as a matter of fact, claim to have had three successful cases, presumably subsequent to the seven cases above mentioned.

In recent years catheterism of the larynx has been resorted to by different physicians and surgeons for the relief of dyspnœa. Weinlechner, of Vienna, in a paper published in 1870,* states that he had used catheterism of the larynx in croup and diphtheria in the St. Annen-Kinderspital since 1866. At first he employed an ordinary elastic catheter, but subsequently constructed vulcanite tubes of different thickness. He speaks well of the treatment, but gives no cases.

Schrötter has for some years employed long vulcanite tubes, the lower extremities of which are of triangular shape like the glottis, for dilatation of the glottic aperture in chronic stenosis. Hack (1878) used a small Schrötter's

* 'Allg. Wien. Med. Zeitung,' March 29th, 1870.

tube in a case of œdema of the glottis occurring in a patient suffering from syphilitic disease of the larynx. He gradually increased the size up to No. 11 in two or three days, leaving the tube *in situ* about an hour and a half at a time.

Macewen published four cases of catheterism of the larynx in 1880.* Two of these were for the relief of dyspnœa. In the remaining cases catheterism was employed with a view of occluding hæmorrhage from the larynx, and for the administration of the anæsthetic during operations about the mouth and throat. Macewen appears to have been the first to employ catheterism for this purpose.

Many other physicians and surgeons have at different times employed catheterism of the larynx, besides those enumerated in the preceding brief historical sketch. Neither catheterism nor intubation, however, can be said to have been ever, generally, or systematically, practised until Dr. O'Dwyer's method was introduced.

* 'Brit. Med. Journ.,' July 24th, 1880.

II.

O'DWYER'S EARLY EXPERIMENTS.

In 1880 Dr. Joseph O'Dwyer, of New York, began a series of experiments at the New York Foundling Asylum, with the operation now universally known as intubation of the larynx. The incentive that led Dr. O'Dwyer to make these experiments was the failure of tracheotomy in his hands both in private practice and at the asylum. He says, "About the time referred to, tracheotomy was looked on with much disfavour at the asylum, for the reason that we could not show a single recovery to demonstrate it usefulness. We had no argument to offer in favour of it except euthanasia, and not a few of even the most intelligent of the laity fail to understand how a child's suffering can be relieved by cutting its throat."

Dr. O'Dwyer first made some trials with a flexible catheter passed through the nose and into the larynx. He was not satisfied with the results, and he then set about constructing a tube which could be placed in the larynx, and which could be retained there and allow the epiglottis to close over it, in swallowing. He was thus following in Bouchut's footsteps, although, as a matter of fact, he was at that time unaware of Bouchut's attempts in the same direction. Between 1880 and 1885 Dr. O'Dwyer, more patient than Bouchut, steadily persevered in his endeavours, profiting by each fresh difficulty and each successive failure to modify and improve his instruments. His first publication was in the 'New York Medical Journal' of August, 1885, and he then stated that he felt there were still improvements needed, but as

several references had already been made to his method in various journals, he considered the time had arrived for him to give a brief account of his instruments and his method of using them.

Dr. O'Dwyer's first attempts were made with a bivalve tube with a narrow transverse diameter, and about an inch long. The tube was so constructed that the blades, which were introduced closed, opened after detachment from the introducing instrument. At the upper end was a shoulder, which prevented the tube from slipping down into the trachea. He made several attempts with this tube, which he variously modified, but he almost invariably found that the dyspnœa soon returned, owing to the swollen mucous membrane protruding between the blades in the infra-glottic division of the larynx.

He then abandoned the bivalve pattern, and tried a plain tube of elliptical form about an inch in length, and provided with a shoulder at the upper end, to prevent it from slipping down into the trachea. These tubes were too easily coughed up. In one instance the lower end of the tube got blocked with membrane. He then tried longer tubes, the longest about an inch and a half, and the shortest somewhat less. These, however, were not retained any better. Still longer tubes were next tried, the longest being about three inches, and the shortest, one inch and three quarters. The length of these tubes was determined upon from a large number of measurements of the larynx and trachea in children, so that the lower end should reach to within half an inch of the bifurcation, thus overcoming obstruction in the trachea as well as the larynx. These tubes were too easily coughed up, or if not rejected, coughing, or even bending the neck, was sufficient to force them upwards, above the tip of the epiglottis, where they would remain until pushed down by the finger.

Dr. O'Dwyer next endeavoured to effect retention of the tube by making it widen out below the part which

fitted the glottic aperture. This was first done by the addition of a wedge-shaped piece of metal, the thick end up, at each side of the tube, about half an inch from the upper extremity. These tubes were retained well, but so much difficulty was experienced in extraction that they had to be given up. Instead of having a sharp projection at each side, the tubes were next made somewhat fusiform in shape; the transverse diameter being increased towards the centre of the tube by having the metal thicker at this point, and making it gradually taper above and below. This design was found to effect the object, and has been retained in O'Dwyer's tubes to the present time.

The earlier tubes used by O'Dwyer had small heads, which rested on the vocal cords, while the shoulder or flange fitted into the ventricles. Such small-headed tubes had the advantage of allowing the constrictors of the larynx and the epiglottis to effect closure of the larynx in swallowing. The disadvantages were found to be that there was a tendency for the swollen tissues to close over above the tube, and that there was a danger of pushing the tube into the trachea in extraction. The size of the head was therefore increased. About the same time that the size of the head was increased, Dr. O'Dwyer diminished the length from a quarter to half an inch, to facilitate the introduction of the tube.

In order to allow freer action for the epiglottis, the posterior part of the tube was made longer than the anterior, so that the upper surface of the head sloped backwards and upwards. Moreover a slight curve backwards was given to the upper part of the tube, which carried the head away from the base of the epiglottis. This backward curve in the upper part of the tube is retained in Dr. O'Dwyer's present tubes, and is very important for two reasons. First, it carries the head away from the base of the epiglottis where the straighter tubes, originally used, often left a mark, sometimes in the form of a

perforating ulcer. Secondly, with every act of swallowing, the base of the tongue, with the epiglottis, tends to press back the upper end of the tube and thus to tilt forward the lower end against the anterior wall of the trachea. Not unfrequently ulceration was found in the wall of the trachea in this situation. The head being carried farther backwards in the present tubes, this tilting forwards of the lower end is largely obviated.

The calibre of O'Dwyer's present tubes will appear to many, at first sight, to be too small to permit of easy respiration, being considerably less than that of the tracheotomy tubes used at corresponding ages. Experience has, however, amply shown that this is not the case. In O'Dwyer's early experiments the tubes had about the same lumen as the trachea, only, to avoid too great pressure on the cords, they were made elliptical instead of cylindrical. Owing, however, to the occurrence of ulceration in the subglottic mucous membrane at the points corresponding to the long diameter of the tube, in every case in which the tube was retained for any time, the long diameter was diminished, and the lumen proportionately lessened. The calibre of the present tubes is thus probably less than half the original dimensions, but, as already stated, experience has shown it to be sufficient.

At the present time the instruments used by the great majority of operators are those which Dr. O'Dwyer thus gradually modified and improved, and which he recommended substantially in their present form some three or four years ago. It speaks well for the care and patience with which he elaborated his methods and instruments, that although many modifications and improvements have been tried by various operators for the purpose of overcoming the unquestioned difficulties which arise in intubation, none of them has been shown to possess very decided advantage, and none has come, at present, into general use.

III.

O'DWYER'S PRESENT INSTRUMENTS.

O'Dwyer's intubation instruments, as now generally sold, consist of a set of five laryngeal tubes, suitable for children of different ages, of an introducer, an extractor, and a gag. Each tube is fitted with a metal plug, or obturator.

The tubes (Figs. 2 and 3) are made of brass, heavily

Fig. 2.

Fig. 3.

Fig. 2.—O'Dwyer's intubation tube viewed from the anterior aspect. Natural size for a child of three or four years of age.
Fig. 3.—Intubation tube, side view.

plated with gold. The lengths are one and a half, one and three quarters, two, two and a quarter, and two and a half inches respectively. They are flattened from side to side, presenting an elliptical form on cross section. The lumen of the largest tube is about a quarter of an

inch by one eighth of an inch, and that of the smallest about half that size. The upper end is expanded into a somewhat oval or diamond-shaped head, with rounded edges, which rests upon the ventricular bands, and prevents the tube from slipping down into the trachea. The posterior end of the head is prominent, and is destined to rest between the arytenoid cartilages. The anterior end is bevelled off, so as to prevent pressure against the base of the epiglottis, and this object is further ensured by a slight curve backwards in the upper end of the tube, which carries the head still more away from this point. There is a small hole in the edge of the head, near the anterior end, through which a thread can be passed.

Immediately below the head the tube is compressed to its smallest diameter, so as to avoid, as much as possible, too great pressure on the vocal cords. A little below this the tube commences to bulge laterally, and the middle of the tube is occupied by a fusiform enlargement, which serves to retain it in the larynx. This enlargement is due to a thickening of the tube wall at each side, there being no corresponding increase in the lumen, which is uniform in size throughout. The distal end of the tube is elliptical in shape, and is very carefully rounded off, so as to present no sharp cutting edge.

Each tube is fitted with a steel plug, or obturator (Fig. 4), made in two pieces, united by a joint in the middle. The distal end is rounded, and fits the lower end of the tube exactly, projecting slightly so as to form a probe-pointed extremity. This prevents injury to the parts during insertion. The upper end of the obturator also fits the tube close, and has a small hole in its upper surface, which enables it to be screwed to the end of the introducer when the tube is about to be used.

The gag (Fig. 5) which is usually supplied with the instruments has no special advantage over many other forms of gag which are in use, and the downward direction of the handles often causes them to come in contact

FIG. 4.—The Obturator.

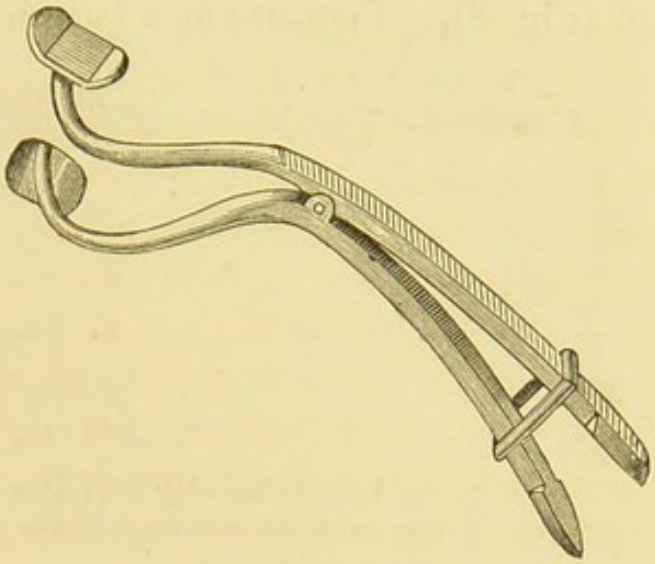

FIG. 5.—O'Dwyer's Gag.

with the child's shoulder when *in situ*. A modification of this gag, in which the handles pass straight back towards the ears, as shown in Fig. 6, will be found more convenient.

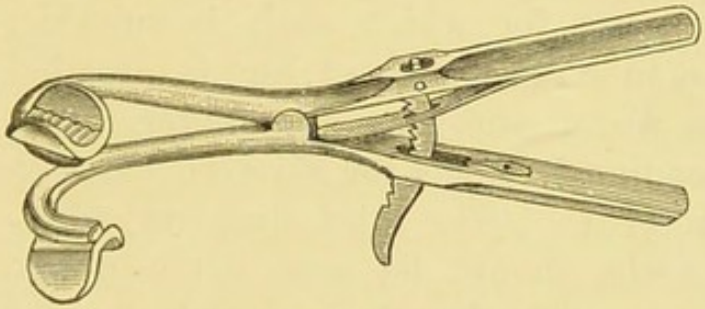

FIG. 6.—Denhard's Gag.

The introducer (Fig. 7) consists of a handle, holding a shank, which is bent near the distal end to a right angle, and over the shank rides a sliding tube. To the end of the

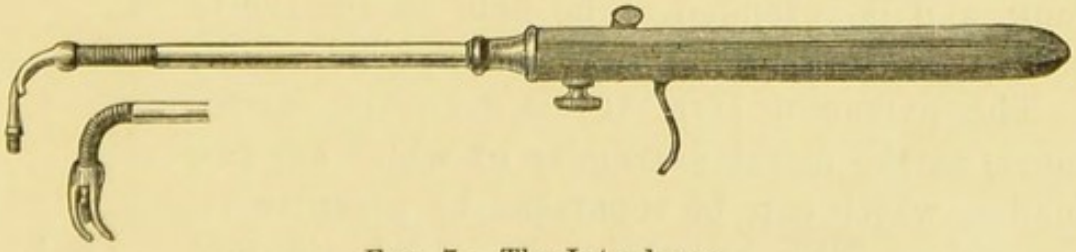

FIG. 7.—The Introducer.

shank the obturator of any selected tube can be screwed on (Fig. 8). Pressure on a button in the handle moves the

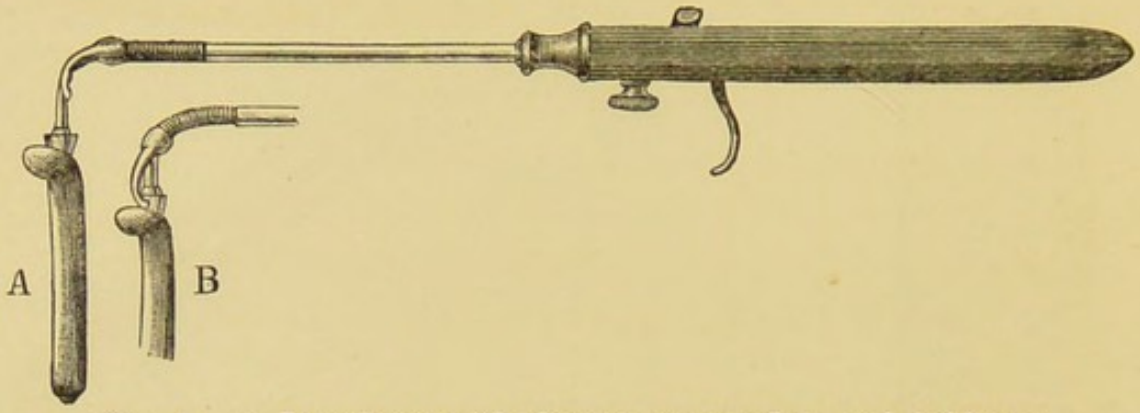

FIG. 8.—A. Introducer with obturator screwed on and holding a tube. B. The tube being pushed off the obturator.

sliding gear, and causes two claws to project downwards on the head of the tube, which push it off clear from the obturator, so that the introducer, and the attached obturator, can be withdrawn when the tube is in place.

A scale (Fig. 9) is supplied with each set, upon which are marked the length of each tube, and the approximate age for which each is suitable. The smallest tube reaches line 1, and is intended for children about one year and under. The next reaches line 2, and is for children between one and two years. The third size, marked 3–4 on the scale, should be used between two and four years. The fourth, marked 5–7, is for the next three years, and the largest tube is for children from eight to twelve. A sixth tube is also made, though not, as far as I have seen, supplied with most of the sets sold in this country. It is two and five eighths inches long, and is intended to be held in reserve in case the fifth tube is too easily expelled.

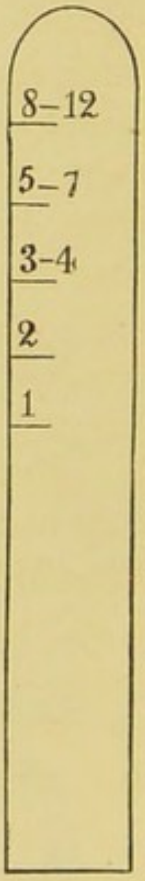

FIG. 9. The Scale.

The extractor (Fig. 10) is a curved instrument, at the distal extremity of which are two blades, which can be separated by pressure on a spring. This extremity is introduced into

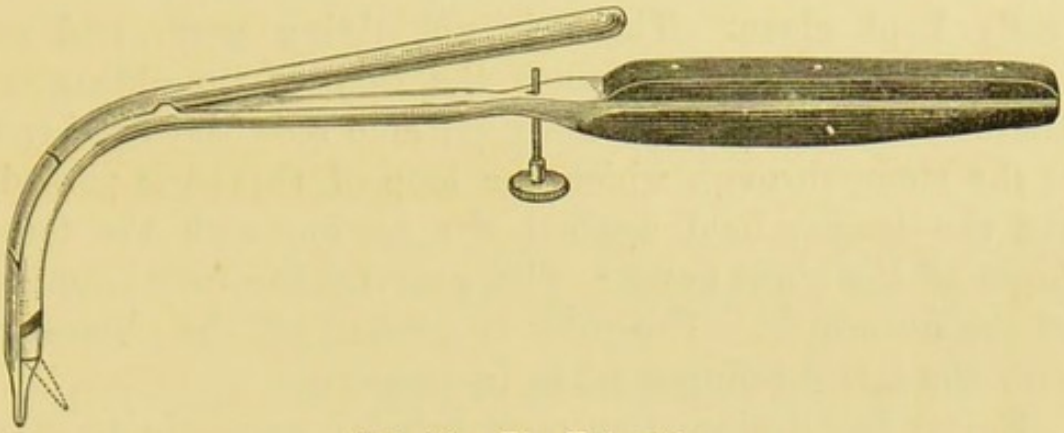

FIG. 10.—The Extractor.

the tube with the blades closed, and, by pressure on the spring, the blades are made to separate, and hold the tube. It is a great advantage to have a regulating screw in the handle, to prevent the blades from opening more than is necessary to hold the tube.

The undoubted difficulties connected with intubation have led to numerous suggested modifications of O'Dwyer's instruments. Thus Waxham, of Chicago, invented a tube which he hoped would facilitate swallowing. Similar in other respects to O'Dwyer's, it was fitted at the upper end with a small metallic lid, or epiglottis, which was held erect, except when swallowing, by a fine gold spring. From his accounts, it seems to have been of service in some cases, but he appears to have abandoned its use.

Bleyer also invented a tube which was automatically closed with each act of deglutition, so as to prevent the entry of fluids or solids into the larynx. The head and the tracheal portion were made of hard rubber, and the neck of soft flexible rubber, so that "during deglutition the adduction of the cords and their accessory muscles closed this soft portion of the tube completely. Afterwards it reopened by its own elasticity." This tube has not recommended itself to any other operator, nor is it clear that the inventor himself has used it to any extent.

W. H. Staveley* has designed an introducer which has the advantage of being simple in construction and very

* 'Lancet,' December 21st, 1889.

easily kept clean. There is no sliding gear, and no arrangement of claws to push the tube off the obturator. There is a small ring on the right side near the distal end of the stem, through which the loop of thread is passed, and the loop is held against the handle with the forefinger of the right hand. This prevents the tube slipping off the obturator. The tube is pushed off the obturator with the left forefinger when in position.

Egidi* has designed an open tubular mandarin to take the place of the obturator. This is fixed to an introducer open in all its length. Respiration is thereby not obstructed during insertion of the tube. He has also modified O'Dwyer's tubes, making them shorter and with larger lumen.

Intubation Tubes for Adults.—In addition to the ordinary intubation instruments above described, larger sized instruments, suitable for adults, have been designed by O'Dwyer. The conformation of the tubes is precisely similar to that of the children's tubes, and the only difference is in the size, and the material from which they are constructed. As adult tubes have been chiefly employed in the treatment of chronic stenosis, a graduated series of ten tubes has been made, although three sizes are quite sufficient for any form of *acute* stenosis. The length of all the adult tubes is the same, viz. three inches. The larger of these tubes are usually constructed of hard rubber; the medium sizes of brass, gold plated, with vulcanite heads to diminish the weight; the smaller of metal only, like those for children. The tubes are introduced and extracted by means of instruments similar in design to those used for children.

* 'La Riforma Medica,' January 5th, 1891.

IV.

METHOD OF PERFORMING INTUBATION.

As the subjects upon whom intubation has to be performed are mostly children suffering from diphtheritic croup, the following description of the operation is designed to apply more especially to such cases.

1. Introduction of the Tube.—The first step is to select a tube suitable to the age of the patient, which is done by reference to the scale. It must be remembered, however, that the same size will not suit every child of the same age, and it will be found that a larger tube than the scale directs will be more often required than the reverse. Moreover, the male larynx in children, as in adults, is larger than the female. The tube should be threaded with a thread of braided silk, about sixteen or eighteen inches long, the ends of which are tied together to prevent its being accidentally pulled out. The obturator is then screwed on to the introducer, and the tube is fitted on to the obturator. It is well to push off the tube once or twice, to see that all works well.

The nurse wraps the child in a shawl, and sitting upright in a straight-backed chair, places the child in her lap, with its back pressed against her left chest, and its head thrown slightly backwards, resting against her left shoulder. She passes her arms round the child, and crossing its forearms in front, holds the wrists securely, while the legs may be secured between her knees. The gag is next placed between the teeth, well back at the left corner of the mouth, so as to keep the mouth wide open. It is held by an assistant, who stands behind the

patient's back, and at the same time holds the head securely in position between his open hands (Fig. 11).

FIG. 11.—Method of performing intubation.

The operator, sitting or standing fairly in front of the child, takes the introducer in his right hand, and hooks the loop of thread round the little finger of the same hand. He rapidly passes the index-finger of his left hand over the tongue and behind the epiglottis, till he feels

the upper aperture of the larynx. He then hooks up the epiglottis with his finger, carries his finger to one side, still holding on to the edge of the epiglottis. With the handle of the introducer held close to the patient's chest, the tube is passed into the mouth and over the base of the tongue, guided by the index-finger, and being kept as fairly in the middle line as possible. As it approaches the epiglottis the tube is brought into the vertical position by rapidly elevating the handle, and the end directed along the tip of the guiding finger, is passed through the glottis. The tube is then pressed gently down till its head rests on the ventricular bands. By pressure on the slide of the handle the tube is set free from the obturator, and the introducer with the attached obturator is withdrawn. The tip of the left index-finger presses the head of the tube, feels that it is in position, and the finger is at once withdrawn.

The entry of the tube into the larynx is signalised by sharp coughing and free expectoration, by easier breathing and disappearance of stridor. The operator being satisfied that the tube is in the larynx, removes the gag and waits a few minutes to allow the cough to take place, and the mucus and perhaps fragments of membrane to be expelled. The gag is then replaced, the loop of thread is cut close to the mouth, and the left index-finger is introduced and pressed against the head of the tube while the thread is withdrawn. Some operators remove the thread as soon as the first cough has occurred, and before the gag is taken out, so as to avoid its reintroduction. It is, however, better not to remove the thread until any tenacious mucus or loose membrane that may be present has been cleared away by the cough. For this reason some operators recommend leaving the thread for half an hour or longer, fastening it about the ear. O'Dwyer finds that the gag is not often necessary for the removal of the thread, as most children will open the mouth so as to allow of its removal.

Dr. G. Bell* states that he performs intubation without the use of the gag. When the child opens its mouth he passes the left index-finger quickly down behind the root of the tongue, gagging follows, and the larynx at once rises to the waiting fingers. At this moment he introduces the tube with the right hand. I do not doubt the possibility of intubating without the use of the gag, although I have not tried it or seen it tried. I do not think, however, that there are any compensating advantages for the greater facility and security afforded by the gag.

2. Extraction of the Tube.—The patient is placed in the same position as for introduction. The gag is inserted as before, and the left index-finger is passed over the base of the tongue until the tip rests on the posterior prominent part of the head of the tube. The extractor in the right hand is quickly introduced, and its point is guided by the palmar surface of the tip of the finger to the upper surface of the head. By drawing the extractor very slightly forwards it will be felt to sink into the opening of the tube. By pressure on the spring in the handle the tube is firmly held by the dilating blades of the extractor, and removed. While the tube is being withdrawn, it is well to keep the left forefinger ready to catch it beneath the head, and draw it forward in case it slips off the extractor, as it is rather apt to do.

Bleyer† states that with a little practice it is not difficult to remove the tube without using the extractor, especially if the operator possesses rather long and slender fingers. The gag is placed in the mouth, and the head held by an assistant in the usual manner. The larynx is steadied and pushed upwards with the right hand, two fingers of the left hand are passed down behind the epiglottis, and the tube is seized between the tips of the fingers and withdrawn.

* 'Journal of the Amer. Med. Assoc.,' August 20th, 1890.

† 'Archives of Pediatrics,' March, 1891.

3. Difficulties and Dangers of the Operation.—Although many writers state that intubation is an extremely simple procedure, this statement requires qualification. Dr. O'Dwyer says, "Nothing could be more erroneous than the prevalent opinion that it is an easy matter to place a tube in the larynx or remove it, but I am satisfied that a single trial will serve to convince most persons of this fact." With moderate dexterity and some practice the operation is fairly easy, but to one not accustomed to put his finger in this part of the throat, the first attempt will be attended with difficulty, not infrequently with failure. Previous practice on the cadaver is therefore highly advisable.

In consequence of its flaccidity the epiglottis may not be easily recognised in young children. The arytenoids in this case are the best guide, and with the finger on these the tube can be passed along the palmar surface into the larynx. In older children or adults it may be difficult to reach the top of the larynx with the finger. Where the parts are swollen and infiltrated it is not very easy to recognise by touch the different parts. In no case must any force be used, or the larynx may be injured. It is important that the introduction should be performed rapidly. If there is difficulty, withdraw the tube and finger, and allow the child to breathe. Several ineffectual attempts are less dangerous than one prolonged attempt, as respiration is suspended during the manipulations at the laryngeal orifice.

If by chance the tube has been placed in the œsophagus, instead of the larynx, there will not be the characteristic spasmodic cough, nor will there be relief of the dyspnœa, and the string will be found gradually shortening as the tube sinks in the œsophagus. In that case the string should be seized and the tube drawn out.

Another accident of a somewhat serious nature may happen in the introduction of the tube. False membrane may be detached and pushed down before the tube,

which cannot be expelled by coughing, and which, by blocking the air passage, may cause urgent symptoms of asphyxia. The accident is a rare one, and is less likely to happen at the first than at a subsequent introduction. Immediate removal of the tube has generally been followed by coughing up of the membrane.

O'Dwyer states that in 200 intubations he has only twice pushed down membrane to a sufficient degree to produce asphyxia. In these two cases, on removal of the tube the membrane was coughed up. In a recent paper by Dr. Dillon Brown* it is stated that he and O'Dwyer have operated upon over 600 cases, and that neither of them has ever had a death, on the table, due to pushing down membrane.

If, when the tube has been introduced, there is evidence of obstruction and marked signs of asphyxia, the tube should be removed at once by means of the attached thread. Should relief not follow, tracheotomy will give another chance, and it is therefore desirable to have facilities for tracheotomy at hand when intubating for diphtheria.

Care should be taken that the gag do not slip, otherwise the operator's finger may be severely bitten. Ingalls mentions a case in which death occurred from diphtheria caused by a bite from this accident. Some operators wear a covering of rubber or metal on the index-finger, to prevent injury in case the gag should slip. Spectacles over the eyes, and a mask of gauze over the nose and mouth, are additional precautions which some operators adopt during the operation in diphtheritic cases.

Difficulty is sometimes experienced in extraction of the tube. Extraction is undoubtedly more difficult than introduction. There is a danger of passing the point of the extractor by the side of the tube into the larynx, when by opening the blades and forcibly withdrawing them the parts may be much injured. This danger is avoided by

* 'Archives of Pediatrics,' January, 1891.

using an extractor with a regulating screw, whereby the blades can be prevented from opening more than is necessary for holding the particular tube that has to be extracted. The tube itself, if the blades are properly inserted, never offers any resistance to withdrawal. Ingalls mentions a case in which the tube was pushed down into the trachea with fatal result during an attempt at extraction. The accident must, however, be excessively rare with the large head with which O'Dwyer's tubes are fitted, and could only result from very awkward manipulation. If, after a few attempts, the operation is not successful, an anæsthetic had better be administered.

It has been recommended by Bleyer, Lennox Browne, and others, to make a laryngoscopic examination of all cases before and after intubation, as by so doing the condition of the parts and the position the membranes occupy will be seen, and the most certain evidence that the tube is in position will be obtained. Dr. Bleyer* has constructed a special form of tongue tractor to facilitate forced laryngoscopy in children. The difficulties of laryngoscopy in such cases, even for the skilled laryngoscopist, are, however, considerable; and as intubation, if it is to be at all generally used, must necessarily be often done by those who have little or no special skill with the laryngoscope, the recommendation cannot be very often carried out. Moreover, the records of the results of various operators prove that the procedure is not in the least degree essential to success.

Intubation in Adults.

Intubation in adults presents certain difficulties which are not experienced with children. The distance from the mouth to the larynx is so much longer that it is often difficult to guide the tube into the larynx with the finger

* 'Archives of Pediatrics,' October, 1888.

and push it home, and indeed if the operator's finger is short he may find it impossible. Although the introduction of the tube may, in its early stage, be conducted by means of the laryngeal mirror, the finger can hardly be dispensed with in the final stage to push the head well down into the larynx. In extracting the tube, however, in the adult, the laryngeal mirror will often be of great service.

V.

MANAGEMENT OF THE PATIENT AFTER INTUBATION.

After the tube has been placed in the larynx, and the first effects of irritation have passed off, respiration will in general be carried on easily and comfortably, and the child, tired out by its previous struggles, will often fall into a quiet sleep. The tube is cleared of mucus by the ordinary efforts of respiration and cough. If it become clogged during the course of the case it will usually be coughed up.

Independently of getting blocked, the tube is sometimes coughed up during the course of the treatment. With a properly selected tube this is not a frequent occurrence. When the tube is very easily coughed up it is an indication that the size used is too small. The tube is almost invariably ejected from the mouth under these circumstances. Nevertheless in some cases it is swallowed, and when this has happened it has always been passed without difficulty *per rectum* in the course of a few days.

The possibility of the tube being swallowed has suggested to some the advisability of retaining the thread when the tube is in position, and fastening it to the left side of the child's head; but the accident is rare, and apparently not dangerous, and the thread is a source of irritation, and is liable to be seized by the child and the tube dragged out. I have, however, seen the thread left in during the whole course of the treatment, without any attempts being made by the child to pull at it. An undoubted advantage which is claimed for leaving the thread

in situ is that if the tube get suddenly blocked with membrane, or otherwise, the nurse or other attendant, who is by, can pull the tube out at once. However, as already mentioned, the tube is generally coughed up if it gets blocked, and any advantage of leaving the thread *in situ* is counterbalanced by the possibility of the child dragging the tube out at any moment, necessitating the summoning of the medical man, who may not be always at easy access. Another objection to the presence of the thread is that it appears sometimes to cause ulceration of the ary-epiglottic fold across which it stretches, as in a case mentioned by Dr. W. Carr.* A few operators draw the thread through the nose with a Belloc's sound, and then fasten it to the side of the face, as they consider its retention, when so arranged, causes less inconvenience and irritation than when it passes out through the mouth.

When during the course of the treatment the tube is coughed out, dyspnœa may set in more or less rapidly according to circumstances. In the majority of cases there is no danger of death from suffocation for some hours, and time is thus allowed to summon the medical attendant. It is as well, when the tube is coughed out, not to reintroduce it immediately, if there is no marked dyspnœa, provided the operator can remain within easy call, as the stenosis will, sometimes, be found to be sufficiently relieved, even as early as the second or third day, to dispense with the tube altogether. An opportunity is thus afforded of getting red of the tube at the earliest possible moment.

In the course of from four to six days the swelling and false membrane will have so far diminished that the tube will usually be coughed up, and it will then probably be found that it is no longer needed. If it be not coughed up about the sixth day, it should be removed with the extractor, and need not be again introduced if the breathing remain easy. It is advisable, however, for the operator to be within call for some hours after

* 'Lancet,' March 28th, 1891.

removal of the tube, however easy the breathing may seem to be, nor is the patient free from all danger of requiring a reintroduction of the tube until two days have elapsed.

Although, in favourable cases, the tube can generally be dispensed with by about the sixth day, it occasionally has to be worn for ten or twelve days, or longer. American operators make no difficulty about leaving the tube in place as long as may be necessary, but several German authorities consider that danger exists of ulceration from pressure if the tube remains long in the larynx. In 104 post-mortems, Ranke* found, not unfrequently, slight erosions of the mucous membrane, and in six cases deep ulceration was observed. The points of election for these effects were the anterior surface of the trachea at a point corresponding to the lower end of the tube, and the inner surface of the cricoid cartilage, especially in front. Believing that the length of time during which the tube is worn has no little influence in the production of ulceration, Ranke recommends that if the tube cannot be dispensed with by the tenth day, tracheotomy should be performed. Other German operators fix a still earlier limit, even as early as the fifth day (Escherich).

The experience of American operators, however, is opposed to the necessity of any such rule. It is doubtful whether the mere duration of the intubation is a determining cause of ulceration. Ulcers have occasionally been found when the tube has been in the larynx forty-eight hours or less. No doubt this may be due to a special vulnerability of the mucous membrane in certain cases, and possibly to a peculiar conformation of the parts; but improperly designed and badly constructed tubes, and unskilful manipulation on the part of the operator, are sometimes answerable for the lesions.

The tube must be extracted at any period of the treatment if there are symptoms of its being obstructed, other-

* 'Münchener Medizinische Wochenschrift,' September 9th, 1890.

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wise most operators do not interfere with it till the fifth or sixth day. Dr. J. M. Bleyer,* however, states that in his later cases he has extracted the tube daily. He has thus been able to dispense with the tube at an earlier period than formerly, and he has taken the opportunity of the tube being out, to give a good supply of food. Widerhofer† also is in favour of daily extraction of the tube. There are no doubt some advantages in this daily removal of the tube, but they are, I think, counterbalanced by the danger of injury to the parts by the frequent removal and introduction of the tube, more especially if the operator is not particularly expert. It is not without significance that Widerhofer, who practised daily removal of the tube, has an unsatisfactory pre-eminence in the amount of ulceration which he describes as resulting from pressure of the tube in his cases.

The feeding of the patient after intubation is sometimes a matter of considerable difficulty. There is, however, a great difference between cases in this respect; for while some patients swallow from the first without difficulty, in others each attempt to swallow any liquid excites cough, owing to its entry in greater or less quantity into the air passages. Soft solids are usually swallowed well. It is therefore recommended to restrict liquids or even to withhold them entirely during the treatment, and to feed the patient on soft pulpy food. When there is difficulty even with such kind of food the patient may be fed with an œsophageal tube, or kept going with nutrient enemata.

It is, however, very often possible to overcome the difficulty of swallowing both liquids and solids by placing the child in a horizontal position with the head hanging down. The child may be placed on its back in the nurse's lap, with the feet a little elevated and the head left to hang down over the nurse's arm (Fig. 12). The actual

* 'New York Medical Journal,' February 2nd, 1889.

† 'Pädiatrische Arbeiten,' Festsch. f. Henoch, 1890.

angle at which the head should hang varies in different cases from 45° to 90°. In this position the child may

FIG. 12.—Feeding the child with head hanging down.

suck through a tube from a bottle or glass, or be fed from a spoon. In some cases the patient swallows as well, or better, lying on the abdomen with the head inclined downwards.

When the tube has been extracted or coughed up advantage should be taken, if there is no urgency in re-

placing it, to feed the child before reintroduction. This rule applies more especially to cases where there is difficulty of swallowing with the tube *in situ*.

Some hoarseness of voice generally remains after the tube has been removed. This, however, mostly disappears within a week or two.

VI.

INTUBATION IN DIPHTHERIA.

Intubation of the larynx, in the vast majority of cases, is performed for the relief of stenosis due to diphtheritic croup. The value of the operation must therefore, in the main, be estimated by a comparison of the results obtained in this disease, with those which are obtained by the alternative operation of tracheotomy. Intubation has now been performed, principally in America, in a sufficiently large number of cases of diphtheritic croup to enable us to form a fair estimate of its value as a means of saving life, and to institute a comparison between the two operations.

Dr. Dillon Brown,* of New York, in 1889 collected 2368 cases of intubation, all of which, with the exception of an insignificant number, were performed in America. They were the record of 166 different operators. Of these cases 647 recovered, giving a percentage of 27·3 recoveries. I have collected from such published records† of the last two years, as were accessible to me, 1849 further cases with 638 recoveries, or 34·7 per cent. Of this number 619 are from European sources, with 31 per cent. recoveries, and 1230 from American sources, with 36 per cent. recoveries. If we add this collection of cases to Dr. Dillon Brown's, we find 4217 cases with 1285 recoveries, or 30·4 per cent.

Let us look now at some of the statistics of trache-

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

† See Appendix I.

otomy. Archambault, in his article on "Croup," in the 'Dictionnaire des Sciences Médicales,' gives the statistics of the tracheotomies in the two Paris children's hospitals, the Hôpital Sainte-Eugénie, and the Hôpital des Enfants Malades. From these we learn that at the Hôpital Sainte-Eugénie, from 1851 to 1878, there were 3020 tracheotomies with 677 recoveries, or 22·5 per cent. In the Hôpital des Enfants Malades, in the same period, there were 2946 cases with 712 recoveries, or 24·2 per cent. Other statistics, covering a larger number of cases, collected from various sources show better results. Thus Agnew* collected 11,696 cases, with 26·25 per cent. recoveries. Stern† collected 8380 cases, with 26·4 per cent. recoveries. Monti,‡ of Vienna, collected 12,736 operations, with 27·6 per cent. recoveries. Lovett and Monroe§ 21,853 cases, with about 28 per cent. recoveries.

From these and other statistics it would be perhaps fair to place the percentage of recoveries in tracheotomy for diphtheritic croup at from 27 to 28 per cent. So far as we can judge from the figures given above the proportion of recoveries after intubation is somewhat larger than after tracheotomy, although the difference is not great, and we are, perhaps, hardly yet in a position to form a final judgment on the matter.

If we now examine the results at various ages, both of intubation and tracheotomy, we shall find that, while intubation probably holds its own at all ages with tracheotomy, the former operation shows a decided advantage over the latter in very young children.

I have collected, as far as I have been able, the published cases‖ of intubation in which the age of each case

* 'System of Surgery,' vol. iii.

† 'Journal of Laryngology,' 1887, p. 34.

‡ 'Croup und Diphtheritis im Kindesalter,' 2, Aufl. Wien., 1884.

§ 'American Journal of Medical Sciences,' July, 1887.

‖ See Appendix II.

was stated, and have tabulated them according to age and result. The total number of cases is 1540, with 474 recoveries, or 30·7 per cent. The percentage of recoveries at each age is shown in the following table.

Of	60	cases	under 1 year	11	recovered, or	18·3	per cent.
„	253	„	2 years	48	„	19·0	„
„	306	„	3 „	67	„	21·9	„
„	326	„	4 „	98	„	30·0	„
„	231	„	5 „	93	„	40·0	„
„	127	„	6 „	48	„	37·8	„
„	83	„	7 „	37	„	44·5	„
„	80	„	8 „	41	„	51·2	„
„	26	„	9 „	13	„	50·0	„
„	23	„	10 „	7	„	30·0	„
„	7	„	11 „	3	„	42·8	„
„	7	„	12 „	4	„	57·1	„
„	11	cases	over 12 „	4	„	36·3	„

The number of cases under one year in the above table is probably too small to draw any final conclusion therefrom, but so far as the figures go they show 18·3 per cent. recoveries at this age. If we take the cases in the first and second years of life, 313 in number, we find about 19 per cent. recoveries, which may be taken as fairly representing the results of intubation in children in the first two years. From that age the ratio of recoveries gradually increases up to six or seven years, after which the numbers at each age are too small to draw conclusions for each age, but of the total number of cases over six years, viz. 237, there are 109 recoveries, or 46 per cent., so that the maximum is reached after six years.

It is well known that tracheotomy gives bad results in very young children with diphtheritic croup. Trousseau, indeed, was at one time inclined to hold that tracheotomy was contra-indicated under two years on account of the bad results obtained. Statistics, however, show that although the proportion of recoveries is not large, there have been quite sufficient successes to prove that age alone

is not a contra-indication. Bourdillat,* in an analysis of 1300 cases, at all ages, found only 3 per cent. recoveries under two years, and 12 per cent. at two years of age. Kronlein† reported 85 cases in the first two years of life, with 11 recoveries, or 13 per cent. Chaym‡ collected from all sources 977 cases of children under two years, with 145 recoveries, or 15 per cent. Of this number, 56 were in children under one year, with 9 recoveries, and 921 between one and two years, with 134 recoveries. Monti§ was able to add to Chaym's figures, so as to bring the number of cases in the first year up to 81, and of those in the second year up to 1012. In the former group there were 11 recoveries, or 13·5 per cent., and in the latter 147 recoveries, or 14·5 per cent. These figures may, therefore, be taken to represent the proportion of recoveries from tracheotomy for diphtheritic croup in the first two years of life in cases collected from all sources.

As age advances the number of recoveries increases after tracheotomy as after intubation, and here also the maximum of recoveries is obtained over six years. This is shown to be the case by the tables of Archambault‖ of the results at the two Paris children's hospitals, as well as by the tables of Bourdillat,¶ Bartels,** Kronlein,†† and Monti.‡‡

Professor Ranke,§§ of Munich, has recently presented some interesting statistics of 413 cases of intubation collected exclusively from German, Austrian, and Swiss (German) sources, which differ in some respects from the

* 'Bullet. de la Soc. Méd. des Hôp.,' 1868, p. 39.
† 'Archiv f. klin. Chirurg.,' Bd. xxi, s. 253.
‡ 'Archiv f. Kinderheilkunde,' Bd. iv, s. 417.
§ Ibid.
‖ Ibid.
¶ Ibid.
** 'Jahrbuch f. Kinderkrankh.,' 1872, p. 402.
†† Ibid.
‡‡ Ibid.
§§ 'Münch. Mediz. Wochensch.,' Sept. 9th and 16th, 1890.

preceding. There were 141 recoveries in this group, or 34 per cent. Of the 413 cases 364 were primary diphtheria, and 49 were secondary to scarlatina or measles. In the 364 cases of primary diphtheria there were 132 recoveries, or 36·2 per cent. In the 49 secondary cases the recoveries were 9, or 18·3 per cent. He proceeds to compare these with 843 tracheotomies collected from the same sources, and performed during recent years. The latter show 340 recoveries, or 38 per cent. The percentage of recoveries in primary diphtheria was 39·8 per cent., and in secondary diphtheria 17·3 per cent. So far as these statistics are concerned the balance is in favour of tracheotomy. The percentage of recoveries it will be noticed, both for intubation and tracheotomy, but especially for tracheotomy, is considerably higher than is shown in statistics dealing with large numbers and collected from all sources.

Ranke's analysis of cases of intubation and tracheotomy performed in children under two years deals with small numbers, but, so far as it goes, it shows 20 per cent. recoveries for intubation in the first year of life, and 23 per cent. in the second year. For tracheotomy the percentage is 6·6 in the first year and 25 in the second year. The superiority of intubation in the first year of life is thus very marked, but in the second year tracheotomy obtains the lead.

There is no doubt that intubation gives better results than tracheotomy in the first year of life, and little doubt that it gives better results in the second year also (Ranke's statistics notwithstanding). After that the difference between the two operations, as far as statistics go, is not sufficiently marked to draw any definite conclusions therefrom.

It is thus clear that intubation in diphtheritic croup is a safe and efficient means of relieving the stenosis ; that, as compared with tracheotomy, it gives better results in very young children, and that it probably holds its own with tracheotomy at all ages. Beyond relieving the

stenosis it has no other influence on the disease, and we can hardly expect to have in the future a much higher proportion of recoveries than the figures given above indicate. The results of tracheotomy in recent years do not differ materially from those of earlier operators. Thus in 1835, Trousseau ('Dict. de Médecine') reported 61 cases by different operators, with 18 recoveries, or 30 per cent. The same authority, in his report on Bouchut's method, states that between 1850 and 1858 there were 466 tracheotomies in the Children's Hospital in Paris, with 126 recoveries, or 27 per cent. It is probable that intubation, in like manner, in the future, will not give a much larger percentage of recoveries than it has hitherto done, unless some advance is made in the treatment of diphtheria. The great proportion of our cases must still continue to succumb to the extension of the disease to the bronchi, as well as to such causes as septic poisoning, pneumonia, and exhaustion.

Quite apart from any advantage which statistics can show for intubation over tracheotomy in a larger percentage of recoveries, there is no doubt that a great many cases of diphtheria have been saved, and will continue to be saved, by the new operation, which would otherwise have died from inability to obtain the consent of parents for the performance of tracheotomy. Intubation being a bloodless operation, involving neither the use of the knife nor an anæsthetic, commends itself more readily to the laity. For the same reason it is not so likely to be deferred till the patient is *in extremis*, as tracheotomy too often is.

As to the comparative difficulty of the two operations, this depends, of course, largely on the experience of the operator. Tracheotomy is admittedly a very difficult operation in young and fat children. In these, intubation must undoubtedly be held to be the easier operation. Intubation, with a moderately skilful operator, is a much more rapid operation, requiring, indeed, considerably less than

a minute for its performance. One important feature of the operation is that in case of difficulty it is always possible to fall back on tracheotomy.

As to after-treatment, no doubt skilful nursing and the supervision of the medical attendant are desirable during the first four or five days after either operation. Nevertheless there is this difference: While on the one hand the tracheotomy tube requires constant attention for the first few days, the intubation tube as a rule takes care of itself. On the other hand, however, a skilled nurse can generally do all that is needful for the tracheotomised patient, but if the intubation tube becomes obstructed or is coughed up, only the medical attendant can remove it or replace it. Experience has, however, shown that these accidents are not very frequent, and that as a rule there is time to summon the physician or surgeon in charge. It would seem, therefore, that for the poor in their own homes, since some risk must be accepted with either operation, intubation is the more suitable.

As to the relative amount of work and care involved in the after-treatment of the two operations, Gay ('Boston Medical and Surgical Journal,' October, 1888) quotes the following testimony of a nurse in the Boston City Hospital, who had had much experience in both operations: "The time we used to spend in taking care of the tracheal tube is now occupied in feeding the children, but on the whole it is less work and more agreeable to take care of intubations."

It must also be mentioned that the average time during which the intubation tube is worn, viz. about five and a half days, is less than the time during which the tracheotomy tube is required. Moreover it must not be forgotten that every now and then the tracheotomy tube, for one reason or another, cannot be dispensed with for a very long time, extending it may be over some years. This complication has been found in many cases to depend upon the formation of cicatricial bands or contractions, or

upon the presence of exuberant granulations in the air passages in the neighbourhood of the tube. So far as I am aware no trouble of this kind has been reported from the employment of an intubation tube, except by Widerhofer, who mentions two cases in which cicatricial stenosis of the larynx necessitating tracheotomy followed the use of the intubation tube. There is, however, as Ranke* points out, strong reason to suspect that the frequent removal and reintroduction of the tubes which Widerhofer practised had something to do with this unique experience.

With O'Dwyer's earlier tubes it was not uncommon for ulceration to occur from pressure of the tube at certain points, more especially at the base of the epiglottis, and in the anterior wall of the trachea opposite the lower end of the tube. With the present tubes, however, this does not occur. Northrup, who has had experience of 103 post-mortems made upon subjects upon whom intubation had been performed, asserts that ulceration is practically never caused by O'Dwyer's present tubes, although it was not infrequent with the tubes formerly used.

It is unnecessary to consider *seriatim* many objections which were raised against intubation when first it was introduced, since a fuller experience has shown that however important they may seem theoretically, they have not prevented the operation from taking rank as a means of saving life not inferior to the alternative operation of tracheotomy. Such objections were, for example, that the indication of rest from the inflamed larynx was not met by intubation, that the aperture of the tube was prone to get blocked, and the expulsion of membranes was hindered. The frequent entry of food and other foreign matters through the tube was also credited with the production of the lobular pneumonia (*Schluckpneumonie*) with which the patients were so often affected. With regard to this latter point, however, it does not appear

* 'Münch. Mediz. Wochensch.,' Sept. 9th and 16th, 1890.

that pneumonia is really more frequent after intubation than after tracheotomy, and careful post-mortem examinations conducted by Northrup, Ranke, Ganghofner, and others have shown that there is no evidence of food having any part in the causation of pneumonia after intubation.

Although the future of intubation as an operation for the relief of diphtheritic croup is firmly assured, it is not contended even by those who most strongly advocate it that it will wholly supplant tracheotomy, and with fuller experience, no doubt, the indications for one or the other operation will be more clearly defined. An attempt in this direction has been recently made by Professor Escherich,* of Graz. This author holds that intubation is best suited for mild cases with slowly developing laryngeal stenosis where the strength is good, and where there are no signs of septic poisoning, and especially where there is no extension of the diphtheritic process to the bronchi, and no lobular pneumonia.

On the other hand, where the strength is weakened by previous disease, or there are symptoms of septic poisoning, where rapid development of stenosis points to speedy spread of the disease to the lower air passages, and especially where the bronchi and lungs are involved, tracheotomy is to be preferred. He further argues that tracheotomy is the preferable operation in the first and second years of life, owing to the weak expiratory power at that age, and the greater facility afforded by the tracheal tube for the expulsion of membrane and secretions ; but this opinion, founded on theoretical grounds, is not in accordance with a comparison of the actual results obtained by the two operations at this period of life.

There is one class of cases where there is no doubt that tracheotomy is the more suitable operation, namely, those cases where the laryngeal stenosis is complicated by great

* "Ueber die Indicationen der Intubation bei Diphtherie des Larynx," 'Wiener klinische Wochenschrift,' Feb. 12th, 1891.

swelling about the tonsils and pharynx, sufficient to constitute, of itself, a serious impediment to respiration. Here the introduction of the intubation tube will often be found to afford only very partial and insufficient relief, much inferior to that afforded by an opening in the trachea.

Even though experience should prove certain cases to be more fitted for tracheotomy, intubation would still find its use, in these cases, as a ready means of affording temporary relief, while preparations were being made for the more serious operation. Tracheotomy could thus be safely deferred to a convenient time, when it could be performed with deliberation. The intubation tube, moreover, when *in situ*, serves as a guide to the trachea, and facilitates the operation in young children.

VII.

INTUBATION IN OTHER FORMS OF ACUTE STENOSIS.

Intubation of the larynx has been so extensively employed in diphtheritic croup, and with such satisfactory results, that it may be said to have taken its place as a well-established operation for the relief of that disease. Perhaps the greatest difficulties which attend intubation are those connected with the false membrane; the danger of its being pushed down before the tube in introduction, the tendency for loose membrane to collect below the tube or to block its lumen, and the difficulty in its expulsion, either through the comparatively narrow passage of the tube, or alongside the tube. In non-membranous forms of stenosis of the larynx these difficulties have not to be encountered, and it is therefore here, perhaps, that intubation is more particularly indicated in preference to tracheotomy. It has the advantage of not inflicting a wound, thus avoiding all danger of septic troubles; and no anæsthetic is needed for its performance. It is therefore more acceptable to the patient and the friends, whose consent is readily obtained. In the hands of one possessing the requisite skill intubation is capable of being performed more easily and far more rapidly than tracheotomy.

The operation has been employed in nearly every form of acute stenosis, and at all ages, and it has proved a safe and effective means of relieving the symptoms. It has been found completely satisfactory in cases of catarrhal croup in children, in the stenosis resulting from scalds,

and in œdema of the larynx from various causes. O'Dwyer,* Simpson,† and others have published cases of acute syphilitic stenosis in adults treated successfully by intubation.

* 'New York Medical Journal,' March 10th, 1888.

† Ibid., Feb. 22nd, 1890.

VIII.

INTUBATION IN CHRONIC STENOSIS OF THE LARYNX.

In a paper read at the International Medical Congress of 1887, Dr. O'Dwyer said: "Had intubation of the larynx proved a complete failure in the treatment of croup, I should still feel amply repaid for the time and expense consumed in developing it, for I believe it offers the most practical and rational method yet devised for the dilatation of chronic stricture of the glottis." He supports this view by the record of five cases treated by intubation.

Since these cases were published many other contributions to this subject have appeared, and it is beyond doubt that intubation, after O'Dwyer's method, has furnished us with an effectual means of treating a large number of these troublesome cases.

In these chronic cases the tube is often worn for very prolonged periods without harm or inconvenience. In one of O'Dwyer's cases, owing to the patient being lost sight of for a length of time, the tube was worn continuously for ten months. Experience has shown, as might have been anticipated, that when the larynx is affected with chronic inflammatory thickening and cicatricial narrowing considerable pressure can be tolerated from tightly fitting tubes without injurious consequences. In introducing the tube, also, in these cases, more or less force may have to be employed, and can be employed without injurious consequences.

The difficulty of deglutition which sometimes is present after the introduction of an intubation tube is not a source of trouble in chronic cases, for deglutition has invariably been found to be carried on quite easily after the first few days, both in children and adults.

Cases of chronic syphilitic stenosis have been satisfactorily dealt with by intubation, a small tube being inserted at first, and after a time being replaced by a larger size. In some cases intubation has been supplemented by incision of cicatricial bands and membranes. The treatment of these cases is troublesome, and often disappointing, whatever method be adopted, and relapses are apt to take place ; but on the whole, as Lefferts* has shown from an analysis of several cases, intubation offers many advantages over the methods hitherto employed in treating syphilitic stenosis.

In the stenosis which sometimes follows tracheotomy, and which renders it impossible to dispense with the tube, intubation has been found a valuable method of treatment. Ranke,† in discussing this subject, gives as the principal causes of difficulty in dispensing with the tracheotomy tube—

1. Granulations growing up in the region of the tracheotomy wound, especially at its upper end.
2. Cicatricial stenosis either at the site of the incision, or at some point in the trachea where the canula presses.
3. Swelling and thickening of the mucous membrane of the larynx between the under surface of the cords and the lower margin of the cricoid (*chorditis inferior hypertrophica*).
4. Bilateral paralysis of the abductors.
5. Paresis of the cords from disuse.
6. Dread of having the canula removed, producing laryngeal spasm.

* 'Medical Record, N. Y.,' Oct. 4th, 1890.

† "Intubation des Kehlkopfes bei erschwertem Décanulement nach Tracheotomie," 'Pädiatrische Arbeiten,' Festsch. f. Henoch, 1890.

In all these forms of difficult *décanulement* Ranke advocates intubation, although his own experience is confined to its employment in the first two forms.

According to Guyer,* von Muralt found intubation successful in curing similar cases. In a case of cicatricial stenosis following tracheotomy, which was treated by von Muralt, the intubation tube was worn for nine months. The child was allowed to return to its home during the treatment, being brought up to the hospital every twelve or fourteen days to have the tube removed and cleaned.

Gampert describes two cases in the Hôpital Trousseau where the attempt to remove the tracheal canula was followed by dyspnœa apparently of a spasmodic character. In one of these the tracheal canula had been worn for forty days, and recovery followed after an intubation tube had been *in situ* thirty-one hours. In the second case the tracheal canula had been worn for seven months, and a cure was effected by intubation in twenty-nine hours.

In the preceding cases, and in others which have been reported by various observers, the simple wearing of an intubation tube, it may be of a greater size than would be employed for a child of the same age with acute stenosis, has effected a complete cure. In other cases, as in those of Pitts and Brook,† cure was effected by incision of the larynx, division of cicatricial bands, and the subsequent wearing of an intubation tube for a time. In a case of Mr. Bruce Clarke's, at the West London Hospital, it was found necessary to employ a tube of greater length than usual, but of the ordinary calibre. This tube reached well beyond the tracheotomy wound, which was rather low down, and in the neighbourhood of which there was much exuberant granulation tissue.

J. F. Baldwin‡ describes a case of papilloma of the larynx cured by intubation. The patient was a boy,

* 'Correspondenz-Blatt. f. Schweitzer Aertze,' 1889.

† 'British Medical Journal,' Dec. 6th, 1890.

‡ 'Medical Record, N. Y.,' March 8th, 1890.

aged eight years, who had suffered from dyspnœa for some years. There was a large papilloma attached by a broad base to the left vocal cord. A large tube was inserted, and the tumour diminished in size, and after several weeks completely disappeared. Ranke* also states that in two cases of diffuse papillomata of the larynx in children he obtained excellent results from prolonged use of intubation tubes. It does not appear, however, that he obtained a cure of the disease in either case.

* 'Münch. Mediz. Wochensch.,' Oct. 15th, 1889.

IX.

INTUBATION IN THE TREATMENT OF FOREIGN BODIES IN THE AIR PASSAGES.

O'Dwyer has constructed a set of tubes for foreign bodies and loose membrane in the trachea and bronchi. These tubes are of seven sizes, and are made of very thin German silver. They are all short, and of the same length, viz. $1\frac{1}{8}$ inches. The head is small; there is no retaining swell, because the tube is held in position by pressure from its large size, and the upper end is not bent away from the epiglottis because the tube is only intended to be left in the larynx for a few hours. The tubes are cylindrical, but slightly smaller at the lower end. The diameter of the smallest is $\frac{7}{32}$ of an inch, and of the largest $\frac{13}{32}$ of an inch. Each tube is fitted with an obturator which gives the tube a probe point during insertion, and the upper end of which can be screwed on an introducing instrument. These tubes are intended to fill the larynx, and it is confidently believed that any foreign body which could enter the larynx could pass out through such a tube, unless it were a substance which increased in size by moisture.

I am not aware of any published cases of the removal of foreign bodies by means of these tubes. The utility of temporarily substituting one of these tubes for the ordinary intubation tube in cases where there was reason to believe that loose membrane was present below the tube has been favourably reported upon by more than one observer. On

the subject Dr. Dillon Brown* says: "In the management of loose membrane in the trachea and bronchi, it is the most satisfactory method that I am familiar with; and if some means can be devised for detaching and breaking up the partly adherent membrane, I believe that it will give us the solution of this problem—the most difficult that forces itself upon the attention of the intubator."

* 'Archives of Pediatrics,' Jan., 1891.

APPENDIX I.

The following are the sources from which the 1849 cases referred to at page 33 were taken. In several instances the number of cases here given will be found to differ from the number actually mentioned in the papers referred to. When this is so, it is due to the fact that some of the cases were already included in Dr. Dillon Brown's table in the 'New York Medical Journal' of March 9th, 1889, and such cases were therefore deducted.

Bleyer, 511 cases with 189 recoveries, 'Arch. of Pediat.,' March, 1891. Root, 200 with 72 recoveries, "Intern. Med. Congr. Berlin," in Semon's 'Centralbl.,' 1890, p. 182. Dillon Brown, 150 with 46 recoveries, 'Arch. of Pediat.,' January, 1891. Ranke, 145 with 39 recoveries, 'Münch. Mediz. Wochensch.,' September 9th, 1890. Waxham, 142 with 63 recoveries, 'Journ. of Amer. Med. Assoc.,' October 11th, 1890. Ganghofner, 122 with 60 recoveries, quoted by Ranke in 'Münch. Mediz. Wochensch.,' September 9th, 1890. v. Muralt, 47 with 16 recoveries, ibid. Widerhofer, 38 with 18 recoveries, ibid. Rauchfuss, 23 with 4 recoveries, ibid (foot-note). Pauli, 10 with no recovery, ibid. Graser, 4 with 1 recovery, ibid. Steffin, Kohts, Seifert, 3 with no recovery, ibid. Jacques, 68 with 21 recoveries, 'Rev. Mens. des. Mal. de l'Enf.,' January, 1891. Hailes, 65 with 11 recoveries, 'Brit. Med. Journ.,' May 24th, 1890. Lester, 58 with 24 recoveries, 'Med. Rec.,' New York, August 30th, 1890. C. H. Hunter, 52

with 16 recoveries, "North-Western Lancet," in Semon's 'Centralbl.,' 1890, p. 522. Urban, 32 with 3 recoveries, 'Deutsch. Zeitsch. f. Chir.,' August, 1890. St. Thomas's Hospital, 22 with 8 recoveries, 'Brit. Med. Journal,' December 6th, 1890, p. 1300. Cheatham, 20 with 14 recoveries, "Cinc. Lancet Clinic.," in 'Arch. of Pediat.,' 1891, p. 319. Staveley, 16 with 7 recoveries, 'Lancet,' October 16th, 1889. Victoria Hospital for Children, in 1890, 15 with 3 recoveries, personally communicated. H. H. Mudd, 15 with no recovery, "Med. Mirror," in Semon's 'Centralbl.,' 1891, p. 316. Sota y Lastra, 14 with 3 recoveries, "Rev. Mens. de Laryngol.,' 1889, p. 441. Lubet-Barbon, 14 with 1 recovery, 'Rev. de Laryngol.,' 1889, p. 636. Children's Hospital, Great Ormond Street, 11 with 1 recovery, 'Brit. Med. Journal,' December 6th, 1890, p. 1300. Schwalbe, 10 with 1 recovery, 'Deutsch. Mediz. Wochensch.,' April 2nd, 1891. Johnston, 8 with 5 recoveries, "Cinc. Lancet Clinic.," in 'Arch. of Pediat.,' 1890, p. 159. West London Hospital, 7 with 2 recoveries, personally communicated. Cole, 6 with 2 recoveries, Chicago Clinique in Semon's 'Centralbl.,' 1891, p. 317. Frier, 6 with 2 recoveries, 'Brit. Med. Journ.,' November 16th, 1889. Manassi, 6 with 3 recoveries, "Internat. Med. Congr. Berlin," in 'Archiv f. Kinderheilk.,' Bd. xii, s. 254. Palmer, 3 with 1 recovery, "Canad. Practit.," in Semon's 'Centralbl.,' 1890, p. 349. Egidi, 3 with no recovery, 'Rev. de Laryngol.,' 1889, p. 634. Donkin, 3 with no recovery, 'Brit. Med. Journal,' December 6th, 1890, p. 1300.

APPENDIX II.

THE following are the sources from which I obtained the materials for the table at page 35, showing the age and result in 1540 cases. The numbers here given will not be found in every instance to correspond with the number of cases dealt with by the authors in the various papers referred to, but this arises from the fact that the particulars as to age were not always sufficient to allow of all the cases being included. Cases where recovery was stated to have been only obtained after a secondary tracheotomy have not been included.

Waxham, 300 cases, "North American Practitioner," in 'Arch. of Pediat.,' February, 1891, p. 154. Dillon Brown, 200 cases, 'New York Med. Journ.,' March 9th, 1889; 50 cases, 'Arch. of Pediat.,' January, 1891; 95 cases, 'Internat. Journal of Med. Sciences,' April, 1891. Bleyer, 206 cases, 'New York Med. Journal,' February 2nd, 1889. O'Dwyer, 50 cases, 'Med. Rec., New York,' October 29th, 1887; 50 cases 'New York Med. Journal,' January 14th, 1888. Huber, 94 cases, 'Med. Rec., New York,' June 28th, 1887; and 'Arch. of Pediat.,' 1889, p. 26. Ranke, 66 cases, 'Jahrb. f. Kinderheilk.,' 1889, p. 316. Ganghofner, 41 cases, 'Jahrb. f. Kinderheilk.,' 1889, p. 340. Widerhofer, 34 cases, 'Pädiatr. Arbeiten,' Festschr. f. Henoch, 1890. Urban, 32 cases, 'Deutsch. Zeitsch. f. Chir.,' 1890, p. 151. Guyer, 27 cases, 'Correspondenz-

Blatt. f. Schweiz. Aertz.,' 1889. Victoria Hospital for Children, 1890, 15 cases, personally communicated. Ingall, 12 cases, 'New York Med. Journal,' July 2nd, 1887. Staveley, 11 cases, 'Lancet,' October 9th, 1889. Pinkham, 10 cases, 'New York Med. Journal,' March 17th, 1888. Schwalbe, 7 cases, 'Deutsch. Mediz. Wochensch.,' April 2nd, 1891. West London Hospital, 7 cases, personally communicated. Jacques, 3 cases, 'Rev. Mens. des Mal. de l'Enf.,' 1889, p. 214. Egidi, 3 cases, 'Rev. de Laryngol.,' 1889, p. 634. Brothers, 2 cases, 'Med. Rec., New York,' July 23rd, 1887, and July 27th, 1889. Deming, 1 case, 'Med. Rec., New York,' February 18th, 1888.

Particulars of the following cases were obtained from a table by Dr. Dillon Brown in the 'Medical Record,' July 23rd, 1887 :—Northrup, 31 ; van Fleet, 22 ; Meyers, 21 ; D. C. Cocks, 21 ; G. H. Cocks, 14 ; Caillé, 13 ; E. L. Cocks, 10 ; J. A. Anderson, 10 ; Reid, 10 ; Simpson, 10 ; McNaughton, 10 ; Eichberg, 6 ; McManus, 5 ; Beck, 5 ; Dunning, 5 ; Hance, 4 ; Jennings, 4 ; Cheatham, 3 ; Mason, 3 ; Hunter, 3 ; Prince, Shaw, and Roberts, 2 each ; Ivins, Wheeler, Case, Langman, Shimwell, Denison, Tipton, and Palmer, 1 each.

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