To strengthen my assertion that tracheotomy can be successful in diphtheria under most unfavorable conditions, I would like to relate some of the circumstances of the last case. The father was a teamster and the home none too comfortable, while the hygienic arrangements left much to be desired. As soon as the disease was declared diphtheria all the neighbors at once departed, leaving the mother and the doctor to do all the nursing and take care of the family besides, for the father having had a brother return from the West after a long absence, celebrated his return and the "miracle" which was being done on his child, in the too common manner, with the usual result, and was of no help for the first two or three days. The first night about 2 o'clock I came down stairs to see how matters were progressing, to find the mother and the patient sound asleep on the bed, and this brother referred to, who had promised to keep awake and watch, lying on the floor also asleep. The mother on the fourth day was attacked by the disease, but the attack proving light, was able to keep on her feet and attend to the child.

In regard to the operation itself, it is not generally a difficult one, but it is very encouraging to those of us who are not in the way of seeing or doing much surgery to find an author like Trousseau saying "provided the canula be introduced into the trachea it really matters little how that has been accomplished, whether the operation has been performed with more or less dexterity, or with more or less rapidity, the result is the same provided there has not been hæmorrhage," and again, Parker, who writes "It is hardly probable that the various structures found in front of the trachea will be individually recognized during the performance of a tracheotomy."

If one will look through the medical journals for the last ten years he will see how much more frequently the operation is done than in the past, and how many more successful results been obtained. I well remember how an old, experienced and able physician discouraged the attempt in my first case, because it was diphtheritic, but I venture to predict that the time is coming, if not here already, when the physician will be just as much expected to open the trachea of a child dying from croup, diphtheritic or not, as he is expected to set a fractured limb or tie a wounded artery.

Since writing the foregoing paper, I have been called to a neighboring village in consultation, to see a child with croup, on whom I operated. The nursing was done entirely by the relatives, the case doing perfectly well and the canula removed permanently on the twelfth day. The operation was done in the kitchen, the patient remaining there until well, it being the only room where it was possible to get the necessary amount of steam generated.

THE DELAYED REMOVAL OF TRACHEOTOMY TUBES, WITH CASES.

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AFTER the performance of tracheotomy in children there is seldom any difficulty in dispensing with the use of the trachea tube after a few days. At the Boston City Hospital in about three hundred tracheotomies there have only been four cases which presented this

difficulty. Ordinarily at the Hospital the tube is removed on the fifth, sixth, or seventh day by cutting the tape and quietly taking it out. No preliminary testing of the passage of air through the larynx by stopping the tube is attempted, and in the overwhelming majority of cases laryngeal breathing is fully established by the time that the tracheal opening is cicatrized. The following four cases are the only ones in which tubes were worn for any considerable time.

I. J. E. C., a fat little boy fifteen months old, a nursing baby, was admitted with his mother May 29, 1885. He had been distressed for breath for two days and at the time of admission he was suffering from very severe dyspnœa with retraction of the soft parts of the chest at each inspiration. There was grayish membrane upon both tonsils, and the glands of the neck were much enlarged. Tracheotomy was at once done by the House Surgeon, and afforded relief. His progress was very favorable, he nursed quite well, drank a few ounces of milk daily, and was but little prostrated. On the sixth day (June 4) the tube was taken out at 11 A.M. and the child breathed quietly without it. At 3 P.M., of the same day, he had such a violent attack of dyspnœa that he would have died had not the nurse at once replaced his tube. He rallied quickly from the extreme prostration caused by this attack and breathed without further trouble until three days later (June 7) when the tube was removed again, but dyspnœa came on at once and it had to be replaced. For two weeks from this time his condition continued the same. His tube was taken out daily, but he was unable to breathe without it and it was always necessary to put it back at once. The wound had closed around the tube and no exuberant granulations were to be seen. It seemed as if the trachea collapsed when the tube was taken out, and so shut off the entrance of air to the lungs. Air certainly passed through the larynx when the tube was stopped, and he began to talk aloud June 22d, in a husky but fairly loud voice. The wound was painted daily with a saturated solution of alum and a smaller but still fenestrated tube was put in. He went out of doors daily and improved in his general condition until July 20, when he was discharged wearing his tube. He reported at the Out-Patient Department from time to time to Dr. Hooper and was under his care until November 15, 1885, when he was readmitted to the hospital for another attempt to remove the tube. It came out with difficulty and a small mass of granulation tissue which had grown through the fenestrum into the tube, was pulled away with it. The boy struggled and strangled a little, but in five minutes he was breathing quietly and the tube was left out, although it had been intended to insert a smaller and a non-fenestrated tube. He had a very croupy cough for two nights and breathed rather noisily when asleep, but without distress. November 21, 1886, he left the Hospital; the wound was closed, his voice clear and natural, and his breathing perfectly normal. He has continued in this condition.

II. Albert W., four years old, was admitted July 5, 1885, suffering from severe dyspnœa. He had had whooping-cough three months previously, and was now suffering from measles, the eruption of which was just disappearing. He had been distressed for breath for three days, and at the time of admission he was struggling with every inspiration and somewhat cya-

notic. Tracheotomy was at once done without ether by Dr. Bolles and complete relief was afforded. He received the usual treatment, one-sixtieth of a grain of corrosive sublimate every hour, and milk and brandy. He got along very well and on the fifth day (July 10), the tube was taken out. Two days afterward he had a violent attack of dyspnoea and the tube was replaced. For a week after this the tube was taken out for a little while each day and the wound painted with copper sulphate and glycerine, on the supposition that exuberant granulations were the cause of the trouble. July 22, the boy was able to get along without the tube and it was taken out and the wound treated with tannic acid solution. July 30, the boy was playing about the ward all day, the wound had wholly closed, his voice was clear and his general condition excellent. That night he had a croupy cough and noisy respiration. This continued through the night and at 6 A.M., July 31, he had an attack of violent dyspnoea with much retraction of the abdomen and soft parts of the chest with each inspiration. The mother refused to have tracheotomy done again, but at 8.30 A.M., he was failing so rapidly that she asked for the operation and tracheotomy was at once done without ether by the House Surgeon. The operation was in the line of the old scar and by no means an easy one. Immediate relief followed the opening of the trachea, the boy rallied quickly under strong stimulation and was soon convalescent.

On the sixth day (August 5), the tube was taken out and left out until the next day when it had to be put back and left in until August 19, when it was left out for thirty-six hours, but an attack of dyspnoea coming on in the night made it necessary to put it back with all possible haste. August 25, a smaller and non-fenestrated tube was substituted for it and September 1, 1885, the boy was discharged wearing that tube. His voice was clear and his condition excellent.

October 3, 1885, he was readmitted, having had his tube plugged for a week, both day and night, and the tube was at once removed. Beyond a croupy cough for a day or two he had no trouble and was discharged October 14. The wound was closed, his voice still clear, and his condition is still good. In neither Case I or Case II was it possible to get a view of the larynx although repeated attempts were made.

III. Mattie S., three years old, was admitted May 1, 1881. Dyspnoea was severe and tracheotomy was done at once without ether, by Dr. Ingalls, and the progress of the case was very favorable. On the seventh day (May 8), the tube was taken out, but an attack of dyspnoea came on in forty minutes and it had to be put back. It was left in for a week and a second trial made May 15; result the same. In another week air was found to pass through the larynx, but the tube could not be dispensed with. June 3, ether was given and the trachea was stitched to the skin around the edges of the wound, but the tube had to be replaced nevertheless. Some improvement followed this, and by the middle of June the tube was kept out most of the time, and only put back temporarily when it was needed, but in a few days her general health failed, and by the 30th she was wearing the tube again. July 5, 1881, she was discharged still wearing it.

From time to time attempts were made to remove it, but all proved unsuccessful. On the evening of July 19, 1883, two years after discharge, the tube had been taken out and cleaned, and her mother was about

to replace it, when the little girl said "I do not want it any more, you need not put it in." She has never had any further trouble.

IV. Clara Z., two years old, had tracheotomy performed at the Hospital for diphtheritic laryngitis, June 16, 1883, by Dr. Ingalls. On the following day she had extensive emphysema of the chest, but this soon disappeared and she got along very nicely. On June 26, the tenth day, the tube was taken out, but had to be replaced in an hour as the child was unable to breathe without it. By July 4, she could breathe through the larynx when the tube was stopped but she had a cough and could not breathe when the tube was taken out. She had a variable progress, and by the early part of August she could not get along without it, even for a minute. At this time she was going out daily and was in good condition. August 13 the inner tube would not go in because of granulations sticking through the fenestrum of the outer one, and August 16, 1883, she was sent to the Children's Hospital to be under the care of Dr. Langmaid. A non-fenestrated tube was substituted for the one that she was wearing, and the size of that was gradually diminished by putting in a smaller and a shorter one every few days. In three weeks she was discharged well, with the wound closed.

The cause of the difficulty in this class of cases is not always clear, but certain pathological conditions have been proved to exist in some of the cases. The commonest of these causes seems to be the obstruction of the air passage by exuberant granulation masses growing from the trachea walls. The irritation caused by the sharp edge of the fenestrum in the trachea tube is probably the cause of much of the trouble, and twenty years ago, Trousseau called attention to the fact that the fenestrum was a useless and a mischievous thing. No tube of ordinary size completely fills the trachea, and air enough passes around it to allow the child to breathe through the larynx when the tube is stopped, if such a process is thought necessary before the final removal of the tube. Again, there is a tendency in certain cases to the formation of exuberant granulations inside the trachea upon the cicatrix during or after the closure of the wound. These granulations may be of the ordinary type, in masses, or worse, moved to and fro by the current of air passing up and down the trachea; they may become pedunculated, and form one or more laryngeal polypi of the size of a pea attached to the wall of the trachea by a pedicle of variable length. Both these conditions have been several times proved by autopsy, by laryngoscopic examination during life, and on opening the trachea to relieve the dyspnoea caused by them, they have been seen and removed.¹ These polypi are a mere consolidation of granulation tissue structure, although they resemble it but little in gross appearance.² Prolonged wearing of the trachea tube is a frequent, but not a necessary cause of this complication.

The class of cases next most common is where the trouble is caused by a spasm of the glottis, the reason for which is very obscure. It is suggested that the cold air, going through the larynx for some time unused to its passage, excites a reflex spasm. Again, that the muscles have been in disuse so long that, unless the constant attention of the patient is directed to the breathing, dyspnoea ensues. This accounts for

¹ Koch: *Archiv für Klin. Chir.*, 1876-77, xx, 544.

² Meyerson: *Wiener Med. Presse*, 1884, p. 860.

³ Ross: *Edin. Med. Journal*, xxviii, 786.

the fact that children have been able to do without their tubes except during sleep. At any rate, for some reason or other, there is a profound disturbance of the innervation of the larynx in which the mental element is very strong. Death has repeatedly occurred in these spasms. Blachez³ tells of a case where a boy had been without his tube only a very short time, after wearing it for over a month. He pinched his finger in the door, became angry, and died at once of suffocation. There was nothing found at the autopsy to account for his death. Kriushaber,⁴ however, lost a case with the same symptoms, who proved to have had a polypus form on the cicatrix. The child had worn a tube for two months, the wound had closed, and his voice was clear. His father and two other physicians were discussing his case in the room and wished to see the scar. His mother started to undress him, he struggled, a paroxysm of dyspnea came on, and he died before help could be afforded. Children in this class of cases have been repeatedly deceived into going without a tube by all sorts of devices, such as wearing a tube without any lumen, a shield without any tube, and the like, and even in a case related by Millard,⁵ a little girl whose trachea wound had closed, wore her tube around her neck hanging by a string, and every effort to take it from her, caused so serious a paroxysm of dyspnea that her life was endangered, and it was only by the most persistent effort on the part of Millard that she was enabled to get along without it.

True post-diphtheritic paralysis of the cords is a third and still less common cause of the trouble. In most cases where there is obstruction a laryngoscopic examination has shown no paralysis, but Gerhardt⁶ recorded a case observed during sleep where there was true paralysis after wearing a tube for three weeks. It is often very hard to distinguish this condition clinically from the nervous spasm mentioned above; the paralysis is of course more regular and not likely to be found more than three months after the occurrence of diphtheria.

Collapse of the trachea walls and cicatricial contraction of the trachea and larynx only remain to be mentioned as possible but infrequent causes of this trouble. The latter is not a condition that we should expect to find immediately after tracheotomy, but Steiner found a larynx completely blocked up by scar tissue nine months after operation, and Blachez found one seriously narrowed in three months; on the whole it is a much later complication than the others mentioned. Some cases are recorded where severe dyspnea in adults was found to be due to a cicatricial band like a hymen stretched across the trachea at the seat of a tracheotomy done when a child. Mougeot, in a report to the French Academy of Medicine, advanced the belief that but few children who had had tracheotomy performed lived to adult life, alleging that they fell victims to obscure disorders the result of a tracheal constriction. In twenty years of inquiry he had never found a military surgeon who had seen a conscript with a tracheotomy scar, and he and all his friends could only recall six instances where tracheotomized children had reached adult life.

The diagnosis between the different conditions is far from easy. Trouble caused by a laryngeal polypus comes late, after the wound has been closed some days,

as in Case II, above. The other conditions are apt to be present at the first removal of the tube. The trouble can be located as laryngeal or not by stopping the trachea tube; if air passes through the larynx the obstruction is tracheal, if not it is laryngeal. In Case I the trouble seems to have been due to collapse of the walls of the trachea when not held apart by the tube. The child was very young and the cartilages of the trachea very pliable, air passed through the larynx when the tube was stopped, and the collapse of the trachea walls could be seen when the tube was out and inspiration was attempted. Case II was a typical case of laryngeal polypus forming on the cicatrix in every respect. Case IV was undoubtedly due to the protrusion of granulations into the trachea, and Case III seems rather more like spasm than paralysis. The long duration, the clear voice, and the character of the recovery seems enough to exclude paralysis.

The prognosis in all these cases is at best rather doubtful. Ross⁷ reported fourteen cases of polypi after tracheotomy (all that had been recorded up to 1883), and of these four had died before a second tracheotomy could be done, seven had a second tracheotomy (five of these recovered), and two had a third operation and were still wearing tubes. Of twenty-six cases of granulation obstruction collected by Köch⁸ five died of suffocation, five wore a tube permanently, or at least many years, and seven got well. The remainder were uncertain. In forty cases from all the causes where a tube had been worn at least two months, collected from the journals and monographs, sixteen were fatal, nineteen cured, and five were still wearing tubes. The proportion of fatal cases is undoubtedly too large, as many cases were merely reported for the sake of the autopsies. The cure was often delayed for years, and the ages of the children in nearly all the cases was from two to four years, one was five and one nine years old. As to the frequency of its occurrence it would be hard to speak; it is evidently a rare complication, and I doubt if there are seventy-five cases on record. Its ætiology is altogether obscure and it is impossible to say in advance which case will offer difficulty in this respect.

The treatment has been as varied as it has been inefficient; here and there some therapeutic proceeding has been followed by a cure, but there will be two other cases where the same thing has failed. The German way is to open the trachea and remove any obstacle that may be found and cauterize the granulations. Other methods have consisted in the passage of bougies and drainage tubes and laminaria tents through the larynx to overcome its spasm and to dilate it. The most rational and by all means the most successful mode of treatment has been the abolition of a fenestrum in the tube and the substitution of smaller and smaller tubes, combined with patient waiting. A large number of the recorded recoveries have been spontaneous, often after the trial of ever so many different treatments and the abandonment of them all. Cauterizing and astringent applications to the granulations has been rarely productive of a cure. Where the trouble is of a mental character of course the indications must be met by suitable treatment.

The complication is altogether a trying and a treacherous one, and the obscurity of the whole subject adds much to its difficulty.

³ Gazette des Hop., 1874, No. 35.

⁴ Gazette des Hopitaux, 1874, Nos. 84 and 85.

⁵ Millard. De la Trache dans le Cas de croup, Paris, 1858.

⁶ Gerhardt Kinderkrankheiten, iii, 2, 326.

⁷ Edin. Med. Journal, xxviii, 2, 1883.

⁸ Archiv. für Klin. Chir. Bd., xx, 540.