article on *Neck* in Vol. VI., and to that on *Tracheotomy* in the first edition of this Handbook.

Anatomical Considerations.—In the performance of the operation of tracheotomy it is highly important that the surgeon keep in mind the anatomical details of the region in which he operates, both as a guide to the successive steps of the operation and as a monitor to cause him to be prepared beforehand for the exigencies likely to arise during its course.

The vascular conditions in the pretracheal space vary so much that the greatest caution should be used in attempting to approach the trachea through it. There is no line of safety to be preserved. Whatever freedom from other complications may be present, the presence at least of an important venous plexus, covering the trachea in the middle line, will demand special precautions for its avoidance, except in occasional instances.

The loose character of the connective tissue which fills the pretracheal space permits great mobility to the trachea both vertically and from side to side. To this mobility is due the mischance, which has happened to some operators, to miss the trachea altogether, by reason of its having been pulled to one side from the line of incision, and to continue their dissection until arrested by the vertebral column. This lax connective-tissue envelope also permits the burrowing of the tube in front or at the side of the trachea when unskilful or hasty attempts at its introduction are made while the lips of the tracheal incision are not properly retracted, and the field of operation is covered with blood. This tissue also favors the burrowing of pus downward into the anterior mediastinum in certain cases.

The cricoid cartilage, being the most easily and certainly identifiable point along the laryngo-tracheal tube from the outside in children, becomes the most important landmark in the anterior median region of the neck by which to determine the first incisions for tracheotomy. If laryngo-tracheotomy, or tracheotomy through the upper rings by depressing the isthmus, is chosen, the cricoid prominence should fall midway in the incisions; if the low operation is to be done, the incision, beginning above over the cricoid, should extend downward from it to the sternum.

The Different Laryngo-tracheal Incisions.—According to the indications which a special case may present, the air tube should be opened at a higher or a lower point of its course. Operations which involve incision through some part or all of the larynx come under the general class of laryngotomy; those involving the trachea alone, under that of tracheotomy; those involving both, under that of laryngo-tracheotomy.

Laryngotomy.—Incision of the larynx may be partial or total. If it involve only the thyroid cartilage, it is designated as thyrotomy; if the cricoid cartilage, cricotomy; if the cricothyroid membrane, intercrico-thyrotomy.

Laryngotomy is indicated whenever it is necessary to gain access to the cavity of the larynx for the relief of conditions that resist operative attacks through the mouth. These conditions include impacted foreign bodies, certain wounds of the larynx, strictures, some cases of acute perichondritis for removal of necrosed cartilages, and, lastly, tumors of the larynx. Intercrico-thyrotomy and cricotomy may be resorted to for the relief of urgent and sudden suffocative symptoms that demand haste. The extent and the superficial position of the crico-thyroid membrane in adults, and the ease with which its position may be recognized just above the rigid and prominent cricoid ring, render its opening by a quick plunge of a knife, in cases of emergency, easy and comparatively safe, even in inexperienced hands.

In general, it may be said that section of the thyroid cartilage is to be avoided if the necessary end can be gained by a section restricted to the lower structures of the larynx, because of the subsequent impairment of the voice which must follow the cicatricial agglutination of the anterior part of the vocal bands, which is inevitable to some extent after thyrotomy. The conditions of each case must, of course, determine the decision of the operator at the time as to the extent of the division of the laryngeal structures which he must make. Division of the crico-thyroid ligament and of the cricoid cartilage will be found sufficient for the removal of many laryngeal polypi and subglottic growths; dislocated fragments, in cases of fractures of the cartilages of the larynx, may be reached and manipulated into position through such an incision; necrosed cartilaginous fragments and impacted foreign bodies may likewise be removed thereby. If more room is desired than the partial laryngotomy affords, the prolongation downward of the incision through as many of the upper rings of the trachea as is necessary may suffice, and is to be preferred to total splitting of the thyroid. When, as the result of the condition for which the operation is to be performed, the vocal apparatus has already been irretrievably damaged, the surgeon may split the thyroid cartilage throughout its whole extent without hesitation, if it may seem desirable in order to render his work more facile and radical.

Tracheotomy.—Incisions of the trachea are classified according to their relation to the isthmus of the thyroid gland. If above the isthmus, the incision is tracheotomia superior, or the high operation; if below, it is tracheotomia inferior, or the low operation; if behind the isthmus, it is tracheotomia media, or the middle operation.

Superior Tracheotomy.—The first ring of the trachea being the only one usually exposed above the isthmus, it is evident that sufficient room for a satisfactory opening into the air tube can be gained only by drawing the isthmus down so as to expose the rings behind it, or by extending the cut upward through the cricoid cartilage. In young children the softness and elasticity of the cricoid make easy its incision and the separation of the parts so as to admit of the introduction of a cannula. The high operation, therefore, is to be considered a crico-tracheotomy. Such an operation has a very considerable field for its employment. In general, whenever the air tube must be opened in haste, or by an inexperienced operator, the high operation is to be chosen. The operative difficulties are less, the parts are more superficial, there is less likelihood of the field being occupied by blood-vessels which would embarrass the operation by being wounded. In young children the cricoid cartilage is the most prominent and easily identified structure of the air tube, and presents a landmark which can be recognized quickly, and as quickly and certainly exposed by the knife of the surgeon. When the imminence of suffocation is such as to demand haste in opening the trachea, every other consideration must for the time be held in abeyance; the dangers of hemorrhage and the relative advantage in the after-history of the case of this or that point of incision into the trachea have to be disregarded. Crico-tracheotomy is the operation to be done under such circumstances, on account of the reasons just given.

Median Tracheotomy.—An incision into that part of the trachea usually covered by the isthmus of the thyroid gland constitutes median tracheotomy. The trachea may be exposed at this point either by pulling it down from above, after loosening its attachments, or by cutting directly through the overlying isthmus. In occasional instances the isthmus is wanting altogether, in which cases the median incision becomes a very simple matter. In cases in which, from the shortness of the neck, the existence of large blood-vessels overlying the trachea immediately below the isthmus, the unusual development of the isthmus, or from the persistence of the thymus gland, the exposure of the trachea below the isthmus is difficult or extra hazardous, the median incision is to be chosen.

Inferior Tracheotomy.—In most of the conditions for which tracheotomy is required the low incision is preferable. In stenosis from diphtheritic laryngitis, in cases of foreign bodies in the air passages (unless there is good evidence that the body is fixed in the larynx or high up

in the trachea), in many cases of chronic laryngeal disease, in cases of stenosis of the trachea, and in cases of preliminary opening of the trachea to facilitate operations upon the larynx, it is desirable to make the opening into the trachea at some distance below the larynx. The recession of the trachea from the surface, and the plexus of blood-vessels in the deep pretracheal space overlying the trachea, make the operation more delicate, and one requiring more deliberation and experience for its proper and safe performance than the higher operations, but with care and attention to the special operative details which the particular conditions of the region demand, the trachea below the isthmus may generally be easily, expeditiously, and safely exposed.

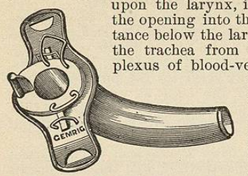

Fig. 4741.—Tracheal Cannula. Ordinary model.

Operative Technique ; Instruments.—The list of instruments which experience has shown me to be desirable to have at hand to facilitate the various steps of a tracheotomy comprises a small scalpel; a small, probe-pointed, curved bistoury; a director; a half-dozen pairs of hæmostatic forceps; two pairs of anatomical forceps; suitable retractors for depressing the suprasternal tissues and for elevating the isthmus; an aneurism needle for possible use in ligating the isthmus; a small, sharp, double hook for fixing and steadying the trachea when it is about to be incised; a pair of blunt double-hook retractors for dilating the tracheal wound; a pair of curved forceps for introduction into the trachea, and, finally, a tracheal cannula. Equipped with these instruments, the surgeon will find himself prepared to cope with any emergency likely to arise in the course of the operation, and by their proper use he can make himself to a great degree independent of assistants.

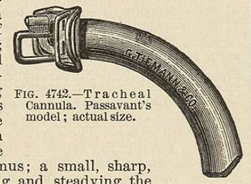

Fig. 4742.—Tracheal Cannula. Passavant's model; actual size.

The Cannula.—In most instances in which tracheotomy has been done, some kind of a cannula will be found indispensable in the after-treatment of the case, to prevent the premature closure of the new respiratory orifice. The model which in general gives best satisfaction is a curved double tube, approximating the quadrant of a circle, which is loosely attached at its outer end to an expanded shield-like plate, to which tapes may be fastened to secure it in place. When this plate is fixed, the tube in the trachea is allowed to move to a considerable extent, to accommodate itself to the movements of the parts. Fig. 4741 shows the cannula as usually found in the instrument shops.

The Material for the Tube.—Silver or aluminum is preferable as the material to use in making the tubes. Hard rubber is objectionable because of the necessarily greater thickness of the walls, which is secured at the expense of the lumen of the tube. Time and use also render the rubber brittle, so that the danger of the tube breaking away from the shield and slipping down into the trachea is created.

For general use four sizes of tubes are desirable, differing in their calibre and curve; and of each size, two different lengths. Let these sizes be denoted respectively by the letters A, B, C, and D, and their dimensions may be presented in tabular form as follows:

Measurements for Tracheal Cannulæ.

Number of size.	Outside diameter of the outer tube.	Length of the Tube Measured upon its Concave Side from Posterior Surface of Shield to Lower End.		Radius of the concave side of the tube.
		Short.	Long.	
A	5.0 mm.	30 mm.	36 mm.	19 mm.
B	6.5 "	30 "	36 "	21 "
C	8.0 "	40 "	50 "	24 "
D	10.0 "	40 "	50 "	29 "

The shield of the tube should be as narrow as possible, that it may neither embarrass flexion and extension of the head, nor cover too much the wound. The form shown in Fig. 4741 is not so desirable as the one shown in Fig. 4742, in which the lock for securing the inner tube is set at the side instead of at the top, as in the ordinary model.

The lower end of the tube should have both its anterior and posterior walls slightly cut away, as shown in Figs. 4742 and 4743; and this lower end of the inner tube should project slightly beyond the outer tube when pushed fully down into its place. A suitable obtunder, slightly projecting from the lower aperture of the inner tube, is desirable for use during the after-treatment of a case of tracheotomy. Its use facilitates the reintroduction of a tube, and diminishes to a minimum the dangers of excoriations and lacerations which are often produced by attempts to introduce without such aid a tube through a partially collapsed channel.

The fenestra, which is commonly put at about the centre of the convexity of the outer tube, is usually undesirable and should not be present in the ordinary tube. Where it is commonly placed it lies partly outside of the lumen of the trachea and permits the soft tissues lining the cannula sinus to press into it whenever the inner tube is removed, so that often, when the inner tube is replaced, it shaves off a slice of the protruding granulations. Its supposed value in facilitating the early appreciation of ability to breathe through the glottis is fanciful.

Anæsthetics.—Except in cases in which more or less complete insensibility is already developed from asphyxia an anæsthetic should be given. But little will usually be required, and it need not be pushed to the full degree considered desirable for most surgical operations. Chloro-

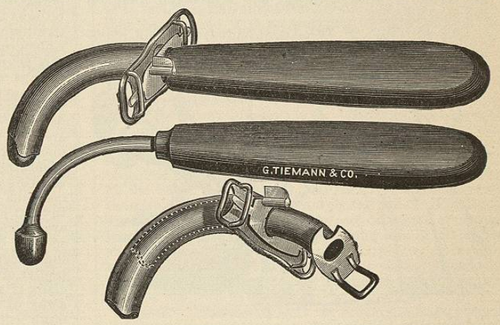

Fig. 4743.—Showing the Relation of the Inner Tube and of the Obtunder to the Tracheal Cannula.

form is to be preferred, as less irritating to the air passages, and especially because its dosage and its effects can be more readily and exactly regulated.

PREPARATIONS FOR THE OPERATION.—*The Table.*—A suitable surface on which to place the patient is the first requisite. It should be high enough to make the surgeon's work convenient, and hard enough to keep the patient's shoulders from sinking down into it. Under no circumstances should the operation be undertaken with the patient lying in bed or in a crib. An ordinary dining or kitchen table answers well. The top of a bureau, if it is not too high, I have repeatedly made use of.

Light.—The more light the better; but usually the surgeon has no choice, and he must make use of what he can get. If the operation is by daylight, the table should be brought close to a window, so that it shall be between the latter and the operator. If the operation is in the night, the lamps and candles must be arranged and held so as especially to illuminate the field of operation. A single candle properly held will give light enough, and is preferable to several lamps placed at a distance. More than one light should, if possible, be provided, lest some mischance to the sole light should cause sudden embarrassment in the course of the operation.

Assistants.—Two assistants are desirable, but if the patient is already insensible, none is absolutely necessary. If an anæsthetic is to be given, one assistant is needed to administer it. He will stand at the head of the patient, and will also be able to render all the assistance needed to hold a retractor or ligate a vessel as the operation proceeds. He may possibly also assist with a sponge, but, as a rule, the operator himself can better do his own sponging. The second assistant is needed only at the feet of the patient to hold the legs quiet and prevent undesirable struggling in case the patient should recover sensibility and should resist before the operation is completed. Any nurse, parent, or friend is quite competent to act as this second assistant.

Sponges.—Small squares of old, soft, and absorbent cotton or linen material, which is always at hand in every household, suffice for sponges. A number of these pieces should be torn and wrung out in hot water, and made ready for use before the beginning of the operation. As fast as one becomes saturated with blood, it is to be thrown away and a fresh one taken.

Miscellanea.—Hot water should be at hand for use in arresting persistent oozing of blood which sometimes is met with; thread for ligating vessels, iodoform for application to the wound surfaces, tape for securing the cannula in position, and a soft catheter or piece of rubber tubing for purposes of insulation, if it should be necessary. A small piece of oiled silk and an ordinary sewing needle, armed with thread, will be needed to complete the final dressing.

THE POSITION OF THE PATIENT.—Everything being ready, the patient is to be placed in position for the

FIG. 4744.—Patient in Position ready for Tracheotomy.

operation. The most important feature of this position is that it shall be one in which the neck of the patient is strongly extended. Upon this point the facility with which the after-steps of the operation may be done will greatly depend. A firm cushion should be placed under the shoulders—not under the neck—so as to lift them up and cause the head to fall back and thus extend the neck as the patient lies on the back (see Fig. 4744).

The desired cushion will usually have to be extemporized from articles to be found in the sick-room. A small pillow made into a firm roll; a bundle of clothing; a bottle with a towel wrapped around it; some books; other like materials may serve for the purposes of this cushion. The front of the chest as well as the neck should be made bare, and the field of operation and the adjacent skin should be cleansed with soap and water, if time permits.

THE OPERATION.—*Inferior Tracheotomy.*—The patient being in position and anæsthetized, and the instruments and sponges arranged on a table or chair within easy reach of the operator, he places himself on the right of the patient. The position of the cricoid cartilage is first identified, by the left index-finger, as the first landmark for the operation. The skin is then made somewhat taut, and the larynx steadied by the thumb placed on one side of it and the fingers on the other, as shown in the illustration (Fig. 4744), and at once with a scalpel in the other hand a free incision is made through the skin and superficial layer of the superficial fascia from the cricoid to the upper border of the sternum. Nothing will be gained but embarrassment in the further steps of the operation by making a less free external incision. If any superficial veins have been divided by this first incision, as is often the case, they are secured by hæmostatic forceps. The deeper layer of fascia is now exposed, and not infrequently upon its surface appear large and swollen branches of the anterior jugular plexus of veins, which so closely approximate each other in the middle line as to make it difficult to avoid them in pursuing the dissection further. The operator will be helped to avoid them by seizing the fascia at the lower end of the incision, just above the sternum, with a pair of forceps and nicking through it, and then, having passed a director underneath the fascia upward to the upper angle of the incision, lifting the fascia upon it. By this manœuvre he puts upon the stretch the tissue in the mid-line between the vein trunks, and can slit it up with much less danger of wounding the vessels than if he continued his incision free-hand. If, however, no vessels appear demanding this use of the director, the deeper layer of fascia may be divided without delay by a stroke of the scalpel to an extent corresponding with the cutaneous incision. A pair of hæmostatic forceps is now fixed in the free border of the incised fascia on either side and permitted to fall outward upon the side of the neck; this retracts the wound edges and freely exposes the connective tissue which joins the inner margins of the anterior ribbon muscles of the neck. The operator now seizes this connective tissue between two pairs of anatomical forceps, and, by causing them to pull against each other again and again, tears his way down to the trachea and freely opens up the pretracheal space. As the dissection deepens, the forceps which have been used as retractors are fixed in the deeper layers of tissue which have been opened up, until they are finally fixed in the tissue that ensheathes the trachea on either side, at the same time securing any bleeding veins that may be torn, while they continue to act as efficient retractors. The inferior thyroid plexus of veins will be identified, as its branches are exposed, and may usually be easily drawn aside and secured out of the field of the dissection by the retracting forceps. At the upper angle of the wound the lower border of the isthmus may encroach upon the field, especially if the isthmus is unusually broad. The clearing away of the pretracheal space should always be thorough enough to uncover and clearly define the lower border of the isthmus. If the breadth or low position of the isthmus is such as to hinder the ready and sufficient exposure of the trachea, it should be pulled up by a proper hooked retractor and held out of the way by an assistant. If, now, all these precautions have been taken, the trachea will be found to be quite superficial

and accessible, on account of the way in which the retracting forceps on either side lift it up from its bed and press back the wound borders. The anterior surface of the trachea should now be cleanly exposed by tearing through any connective tissue that may still cover it; any large vessels that may have been unavoidably wounded and temporarily secured by forceps should be tied; if possible all capillary oozing should also be stanched, although if the method described is adopted it will be rare that any troublesome hemorrhage will be met with. The anterior wall of the trachea is now to be hooked up in the middle line by a tenaculum, and held steadily by the operator with one hand, while, with the scalpel in the other hand, he pushes the point of the knife through the wall of the trachea into its cavity. The hiss of escaping air announces that the cavity of the trachea has been penetrated. The sharp-pointed scalpel is now laid aside, and the probe-pointed, curved bistoury is taken and, its point having been introduced through the opening into the trachea, the incision is carefully enlarged, either upward or downward, as may seem most judicious in the particular case, until the length of the incision is at least one and a half times as great as the diameter of the tube which is to be inserted. The incision should be made deliberately, with a full and exact knowledge of just where and to what extent tissue is being cut. Except in the most urgent cases, in which respiration has already actually ceased, there will be ample time to make the careful and systematic approach to the trachea which has been described. The doing of it takes by no means as much time as the description of it; for one who is at all experienced in the work, five minutes will not be required from the time the first incision is made till the cut in the trachea is accomplished and the new respiratory orifice is provided. As soon as the cut into the trachea has been made, the operator takes the tracheal retracting hooks, and, placing the hooks in the incision, from either side retracts the edges and dilates widely the new opening. One or both of these hooks may now be entrusted to an assistant, while the hands of the operator are set at liberty for the further cares which the case may demand. A tube should not at once be thrust into the opening, but it should be kept patent by the retractors, while a careful inspection of the interior of the trachea is made. In many cases in which the operation has been done on account of pseudomembranous disease, immediately upon the incision being dilated, there will occur a copious ejection through it of membranous débris and of muco-pus, and not infrequently of large membranous flakes, and even complete casts of the trachea. If the respiration has apparently ceased and artificial respiration is resorted to for resuscitation, firm compression of the thorax may cause the liquid contents of the trachea and the bronchi to well up out of the opening. Every care by immediate sponging should, of course, be taken to prevent the sucking back into the trachea of these materials.

In the cases in which tracheotomy has been done on account of a foreign body in the air passages, the exploration of the trachea for its detection and removal will follow as the next step after the trachea has been opened into. When the healthy trachea has been opened for the relief of laryngeal obstruction, or for preventive reasons, the immediate insertion of a cannula is to be made; in the cases, however, in which the trachea, when opened, is found to contain an exudate that is in process of exfoliation, every effort should be made to secure its removal before the cannula is introduced. For this purpose a chicken's feather may be passed down into the trachea and twisted about. This will often be efficient in detaching membranous bits and in provoking a spasm of coughing sufficient to expel them. Curved exploring forceps may be carried down into the trachea directly to seize and withdraw portions of exfoliating membrane. Their introduction will cause a strong expulsive cough, which will tend to loosen and drive between their open jaws any exudate not too firmly attached. I often fasten a small piece of sponge or soft rag in the jaws of the forceps, and introduce the forceps thus armed into the trachea, like a swab, more thoroughly to cleanse its interior. If, by any mischance, considerable blood should have entered the trachea from the operation wound, the same measures to secure its removal, as far as possible, should also be resorted to.

Before the cannula is put in place, while the tracheal opening is still kept patent by the hooks, the toilet of the external wound should be made. All hæmostatic forceps still in use should be removed, and final hæmostasis effected. The wound surfaces should be lightly dusted with iodoform or bismuth, after which the cannula, armed with its retaining tape, should be gently put in place, its tracheal portion being slipped into the trachea, while the edges of the tracheal wound are sufficiently separated by the dilating hooks to permit its entrance. If the cannula is so large as somewhat to distend the trachea, and it is necessary, or is deemed best, to use so large a one, it should not be crowded down the trachea; but if its end is once fairly engaged within the trachea, it will soon gradually work its own way down as far as it can get. The immediate effect of the introduction of the cannula is to excite a spasm of coughing, which, however, usually soon ceases. The cannula should be gently held in place by the fingers of the operator until this storm of coughing has subsided. The tapes should then be passed around the neck and tied so as to hold the cannula securely in place. Care should be taken, in tying the tapes, not to draw them too tight at first, but, while they are tight enough to prevent the end of the tube from slipping out of the trachea, still to have sufficient slack to provide for the swelling of the neck from infiltration of the borders of the wound, which always occurs within the first twenty-four hours after an operation. Otherwise the tapes will soon become too tight, and will cause much suffering to the patient if delay in frequent examination of them should occur.

The final dressings may now be applied. If the external wound has been made so freely upward as to extend considerably above the upper edge of the shield of the cannula a single suture may be applied so as to diminish the extent of the gaping here; but this will rarely be required. No attempt at suturing the lower portion of the wound should ever be made, lest retention of secretions and their burrowing downward behind the sternum be occasioned. A small compress should be made out of any thin, soft material, as an old pocket-handkerchief, or prepared gauze. It should be large enough to cover the wound and extend out on either side to the outer border of the flanges of the shield of the cannula. This compress should be slit down to its centre on one side so as to facilitate its application around the tube; it should then be smeared with an ointment of oxide of zinc and salicylic acid (oxide of zinc, gr. x.; salicylic acid, gr. iij.; vaseline, ʒ ss.), and, finally, should be applied around the tube and under the shield, so as to cover and protect the whole wound. Next, a bib made of oiled silk should be applied to the front of the neck and half-way down the front of the chest. It should be secured around the neck, having been cut away at the top so that its upper edge may easily be slipped under the lower edge of the shield, between it and the compress. The object of this is to protect the necessarily exposed parts of the chest from the air and from the secretions continually being expelled through the tube. Finally, a small veil made of two thicknesses of gauze or similar material, or a thin, flat sponge wrung out in hot water, should be adjusted over the external opening of the cannula to keep out dust and to moisten somewhat the inhaled air; the dressing is now complete, and the patient may be removed to his bed.

Superior Tracheotomy.—If the trachea is to be entered above the thyroid isthmus, the cricoid cartilage is again the landmark which is first to be identified. The skin and superficial fascia are to be divided by an incision at least one and a half inches long, the centre of which should fall upon the cricoid. The deep fascia may next be divided by free dissection, or upon a director. The

thin connective-tissue layer which lies underneath is then to be divided carefully, or torn with forceps, so as to expose the surface of the cricoid. A careful transverse incision or tear of the fascia, which is attached to the lower border of the cricoid, is then to be made. This will loosen the isthmus from its attachment to the trachea, and now, with a suitable hooked retractor, the isthmus is to be pulled downward as far as possible. The upper two or three rings of the trachea are now exposed; the sides of the wound should be kept apart by the catch-forceps, as in the low operation, the fixation hook should be inserted into the cricoid, and a longitudinal incision, cutting from below upward, made through the exposed rings of the trachea after the manner already described. If the incision made into the trachea does not give room enough for the easy introduction of the cannula, the cricoid also is to be divided. The toilet of the trachea and of the wound, and the placing of the cannula, are to be done in the same way as already described for the low operation. In those urgent cases in which at every hazard an immediate opening must be made into the windpipe, the following method is to be followed: It is the work of but a moment to get the child upon a table, get a book or cushion under its shoulders, and tear away the clothing from in front of its neck. The larynx then being steadied and made prominent by the thumb and fingers of the left hand, with one free stroke of the scalpel in the other hand, all the superficial tissues are divided down to the cricoid and the isthmus; possibly the latter is also divided by this single cut. Does free bleeding follow the cut, the tissue from which the bleeding comes is seized *en masse* in the grasp of an hæmostatic forceps, with another stroke of the scalpel the trachea is opened, then the hook retractors are inserted, and the opening is dilated. There is always some one by to whom the dilating hooks can now be entrusted, while the surgeon institutes artificial respiration if needed, or seizes any vessels that may be bleeding, or removes any masses of exudate that may be blocking up the trachea. Free respiration having been re-established, haste is over, and all that is further required, including the introduction of the cannula, may be done with deliberation.

Complications of the Operation.—Varying conditions of pretracheal vascularity may embarrass the ready performance of any of the different methods of tracheotomy. It is by ignoring these conditions, by using too much haste in operating, by the lack of needed instruments, or by other imperfections in operative technique, perhaps unavoidable on account of emergency, that most of the serious accidental complications of tracheotomy are caused. The following list of complications is to be considered: Hemorrhage, asphyxia, displacement of the trachea, faulty incisions into the trachea, failure to introduce the cannula into the trachea, emphysema, and fatal syncope.

Hemorrhage.—The occurrence of hemorrhage is the most frequent of the accidents that complicate tracheotomy, and the one which brings in its train most of the other accidents enumerated. None of the precautions for the avoidance of hemorrhage which have been described in the section devoted to operative technique is unimportant. It is important that, if possible, bleeding should be arrested before the trachea is opened, but it may happen that delay for such a purpose may itself be fatal from the unrelieved asphyxia. When suffocation is imminent, therefore, the surgeon must, regardless of hemorrhage, boldly and rapidly proceed with his efforts to open the trachea. When the trachea has thus been opened through a pool of blood, the immediate introduction of the cannula is required, for the special purpose of preventing the flooding of the trachea with blood as well as for furnishing a conduit for the air. As soon as free respiration is again established, the bleeding will usually cease spontaneously, or may easily be controlled by pressure.

Hemorrhage from the vessels of the tracheal mucous membrane may also be a source of trouble. However perfectly bleeding may have been arrested before the trachea is opened, some hemorrhage from the divided vessels of the tracheal mucous membrane will follow the incision of the trachea. The blood flows into the trachea, but its flow usually ceases spontaneously, and the small quantity that has been effused is readily coughed out.

Cases of persistent internal hemorrhage from the tracheal vessels proper are fortunately rare. In such instances there will have been profound blood-poisoning antecedent to the operation. The method of operating, and of dealing with the trachea, which has already been advocated in the previous pages of this paper, will be the one best adapted for early discovering and successfully overcoming this complication.

Asphyxia.—The asphyxiative symptoms may be aggravated in some cases by the anæsthetic itself. Another source of aggravation, incident especially to the low operation, is liable to be present in very young children whose tracheal rings are not very resistant. When the deep fascia is incised and the deep pretracheal space is opened up, an important protection to the trachea from external pressure is lost, so that the soft tube is exposed to the full effects of atmospheric pressure at every attempt at respiration. A certain amount of collapse of the trachea may thus be caused, with speedy asphyxia unless the tube is quickly opened. This will occur, of course, only when the laryngeal obstruction is already very great, and therefore is more likely to complicate those operations that are deferred until the suffocative symptoms have already become extreme. This is the cause of the marked increase in the asphyxiative symptoms which so often develop during an operation, and alarm the surgeon lest the patient die before the trachea is opened. It is just at this crisis that, in his haste and solicitude, the operator is most likely to wound a vessel and add to the existing perils the dangers and difficulties of a sudden flooding of the wound with blood. To delay to stanch the bleeding would be fatal, to find the trachea through the deep, narrow wound filled with blood is difficult, and to incise it thus obscured is hazardous; but nevertheless, in such an emergency, it must be done as the only resource. The surgeon may properly protest against the delay in operating which should expose his patient to such perils, but in many cases the time of operating is not a matter of choice, for he may not arrive at the bedside of the patient until extreme symptoms have already developed. As soon as the trachea is opened, if done under such circumstances of hemorrhage, the patient should be turned over on his face to prevent the flow of blood into the trachea; if breathing has already ceased artificial respiration must be instituted; if the trachea has been flooded with blood it must be forced out by compression of the thorax, and by blowing air into the bronchi through a tube, as a catheter, so as to excite expulsive cough. It should be noted, however, that in any case the amount of time required for such a careful and systematic exposure of the trachea as would suffice to guard against operative mischance is so short that the surgeon need rarely feel himself compelled to depart from the cool, safe, and regular prosecution of his work. The preservation of a dry wound, and the obtaining of a clear, unobstructed opening into the trachea are the very best safeguards against the occurrence of uncontrollable asphyxia, and to secure these he may well disregard for the moment threatening asphyxia, relying on his ability to re-excite respiration by artificial means if it should actually cease before the opening in the trachea is made. Fatal asphyxia may be caused by a plug of false membrane crowded down into the trachea before a hastily introduced tube. A thick and loosely adherent lining of membrane may be pushed before the point of the knife which cuts the more resistant tracheal wall, and a hastily introduced tube, pushing its way between the membrane and the wall of the trachea, may find itself within the trachea, but still shut off from its cavity by this membranous layer. Death from asphyxia may occur before the cause is recognized and remedied. In general, as to these dangers, it may be said that prevention is better than cure. If care is taken to have the trachea clear of loose exudate before the cannula is inserted, such accidents cannot happen. If, however, as the result of circumstances beyond his control, the surgeon finds himself confronted by this accident, as indicated by increased embarrassment to the breathing or its total cessation upon the introduction of the cannula, the latter must be at once withdrawn, the tracheal opening dilated, perhaps enlarged, and, by the use of forceps, swabs, syringes, inflating tubes, or feathers, the cavity of the trachea must be quickly cleared, and artificial respiration resorted to.

Displacement of the Trachea.—The trachea may have been dragged or pushed away from its proper position in the median line by tumors. A more frequent cause of displacement of the trachea is unequal retraction of the borders of the wound in the course of the dissection to expose it, or unintentional departure from the midline of the neck by the surgeon. The result is that the operator strikes the trachea laterally, or misses it altogether. Cases are recorded in which the operator, having thus missed the trachea, has continued his dissection until the vertebral column was reached. Such mischances are most likely to occur when the field of operation is obscured by blood, and an inexperienced operator is under the pressure of symptoms demanding haste.

To guard against such accidents it is important that the landmarks for the operation which have been described in earlier sections be identified at the outset of the operation, and that, when haste in operating is imperative, the larynx should be steadied and the tissues evenly retracted by the fingers of one hand, while the incisions are made with the other.

Faulty Incisions into the Trachea.—These include lateral incisions, multiple incisions, too short incisions, too long incisions, and complete transfixion of the trachea with penetration into the œsophagus. They are generally the result of haste and hemorrhage. A lateral incision will make the cannula stand awry upon the surface of the neck, and increase the dangers of irritation to the tracheal mucous membrane from its extremity. Multiple incisions are the result of repeated ineffectual stabs at the trachea when the first incision is lost beneath shifting tissues or in a pool of blood.

When a puncture has been made and lost, so that it cannot quickly be found again, time should not be wasted in searching for it, but a new incision should be made. Too short an incision interferes with the ready introduction of a tube; too long an incision leads to difficulty in retaining a tube in the trachea. The length of the incision should not exceed one and a half times the diameter of the tube that is to be inserted, and when the tracheal cartilages are too rigid to permit ready separation of the edges of the incision to a sufficient extent, exsection of a portion of them should be done.

Complete transfixion of the trachea may easily be done in young children in whom the tracheal walls are quite soft, and possibly already somewhat collapsed. It is to prevent this accident that the recommendation is made to hold up and steady the anterior wall of the trachea by a fixation hook or tenaculum before it is carefully pierced by the point of the knife. Attempts to open the trachea by quick thrusts of the knife should never be made.

Failure to Introduce the Cannula into the Trachea.—Death before the cannula is introduced, on account of delay from some of the accidents already mentioned, has occurred many times. There can be no excuse for leaving a cannula thrust down by the side or in front of the trachea. Such an accident can happen only when the incision in the trachea is imperfectly exposed and retracted, perhaps hidden by blood, or when the trachea has been missed altogether. The rush of air through the tube when it enters the windpipe is unmistakable, and the operator should never be satisfied until the free current of air in and out of the tube clearly demonstrates that it is properly in place.

Emphysema.—When emphysema follows a tracheotomy, it must be produced by some operative mischance whereby the peritracheal connective tissue is opened up deeply without corresponding external wound, or lateral or multiple incisions into the trachea have been made, or an incision into which the cannula either has not been introduced at all or has slipped out of, so that the expired air is forced into the connective tissue. Though the cannula may have been properly introduced at first, it may slip out of its place later, either because too loosely tied in, or because the tracheal incision is too long, or because the tracheal cannula is too short from the first, or the subsequent tumefaction of the tissues lengthens the track so that it becomes too short later.

The appearance of the emphysema may be first noted during the operation, or it may not be noted until some hours have passed, depending upon the time when the causes of it become active. It may be limited to the region of the wound, or may in extreme cases become generalized. As soon as its cause is removed, it will rapidly subside.

Syncope.—A transient syncope occurs in some cases immediately upon the incision into the trachea being made, caused by the sudden free in-rushing of an abundant stream of air. For a moment further inspiratory efforts cease, and the child appears as if it would never breathe again. There is no cause for anxiety, however, since the momentary shock is quickly rallied from and regular respiration begins again. Compression of the thorax and dashing cold water into the face of the patient may be resorted to, if the syncope is prolonged.

Fatal syncope may occur at any stage of the operation in children who are the subjects of diphtheria, from heart failure determined by agitation, hemorrhage, or possibly the anæsthetic.

After-treatment.—Much difficulty is often experienced in inducing children to take the needed amount of food, not necessarily because it hurts them to swallow, but because of their general state. Not infrequently, also, such paralytic weakness of the pharyngeal and laryngeal muscles develops that, at every attempt to swallow, more or less food will enter the larynx and provoke violent coughing. Rectal enemata, or feeding through an œsophageal tube, must be resorted to in such cases. The general principles of dietetics which are recognized in other cases attended with exhaustion will find their application in the after-treatment of tracheotomized patients. The air should be pure and abundant, as well as warm and moist. I can see no advantage to be gained from shutting up the patient in a close tent, or in maintaining the temperature of the sick-room at a very high point and having it filled with steam, which cannot be equally well obtained from simple and less depressing measures. A temperature of from 72° to 75° F. is high enough. The floating dust of the air should be strained out, and additional moisture given to the in-going current of air by keeping the orifice of the tube covered with a moist veil or sponge. The fact must not be lost sight of that the pre-existing condition of congestion of the pulmonary and bronchial capillaries induced by prolonged dyspnœa predisposes to the development of pneumonia and bronchitis—of which the entrance of blood into the air passages, the aspiration of portions of food and of necrotic bits of exudate, or unhealthy secretions from the larynx and trachea, may frequently be the final determining cause. It is important, therefore, to keep from the respiratory tract as far as possible every depressing influence; hence the importance of the injunction that the air supplied should not only be warm and moist, but also abundant and pure. In no class of cases is the value of intelligent and careful nursing more marked, and it would be greatly to the advantage of the little unfortunates in large cities, where diphtheritic croup prevails, if all such cases could be kept after tracheotomy in special wards of hospitals, equipped with every facility for their proper care. Traumatic fever, to some extent, is unavoidable from the character of the wound. If no complication in the course of the wound healing takes place, the fever will demand no special treatment; if it is excessive and prolonged, the