the cervical spine, the convexity being on the side opposite the contraction. Later, secondary curvature of the spine develops. Usually, there are also an increase of the dorsal convexity, "round shoulders," and a lateral compensatory curve in the direction opposed to the superior deformity.

If the deformity persists the neighboring muscles become eventually involved, together with the other tissues on the contracted side, the fascia presenting the greatest resistance to the correction.

Non-Operative Treatment of Congenital Torticollis.—If the deformity is discovered in early infancy it may be overcome, in many instances, by massage and stretching. In this manipulation one person holds the arm firmly, and another draws the head in the opposite direction, meanwhile vigorously massaging the contracted tissues. This treatment is carried out twice daily for about ten minutes each time. In holding the child and arranging the pillow during sleep, one should take advantage of postures that oppose the deformity.

Hæmatoma.—As has been stated, hæmatoma is not unusual after difficult labor. It forms a hard, resistant, ovoid swelling in the substance of the sterno-mastoid muscle. It is usually discovered about the second week after birth. Its absorption may be hastened by massage with some bland ointment. If there is a tendency toward contraction or toward a posture that might favor deformity, this should be prevented by manipulation and by posture.

Operative Treatment.—If the muscle or muscles are actually shortened, and if deformity cannot be overcome by manipulation in the manner described, operative treatment is indicated. This statement applies to practically all forms of torticollis, whether congenital or acquired, in which the deformity is persistent. The treatment of acute torticollis, and the prevention of deformity will be described later. The object of operative treatment is

FIG. 4739.—The Method of Applying the Plaster Bandage after Operation on the Left Side, to Hold the Head in the Attitude of Overcorrection. (From Whitman's "Orthopedic Surgery.")

to overcorrect the deformity and to hold the head in the overcorrected position until the parts are thoroughly adjusted to their new relations.

Forcible Correction.—The patient having been anæsthetized the shoulders are elevated upon a hard pillow, the arm is then held firmly by an assistant, and the operator begins a series of forcible movements, alternately stretching and relaxing the contracted parts and forcibly massaging them with the ulnar border of the hand. If the shortened muscles are very resistant, it is well to divide the tendinous insertions subcutaneously as a preliminary measure. In this operation the tendon being grasped between the thumb and finger, it may be divided without fear of injuring the deeper parts. One then proceeds with the forcible manipulation until all resistance has been overcome, and until the lateral curvature in the cervical region has entirely disappeared. The head is then fixed in the attitude of extreme overcorrection by means of a plaster bandage. This should include the upper part of the chest and shoulders, circular turns being made about the head. It should remain in position for at least three weeks, and for a much longer time if the appliance is comfortable, and if it is not considered objectionable. After removal of the supporting bandage the head should be turned forcibly from time to time into the attitude of overcorrection, for the purpose of preventing recurrence of deformity; and systematic exercises should be employed to strengthen the muscles and to re-establish the normal poise.

The Open Operation.—In many instances, and especially in cases of long standing in older subjects, the open operation is to be preferred to tenotomy and forcible stretching. An incision, parallel to the sterno-mastoid muscle and half-way between its two insertions, is made, running upward from the clavicle about an inch and a half. Through this incision all the resistant bands are divided as they appear under tension. When all resistance to overcorrection has been removed, forcible manipulation is carried out and the head is fixed in the manner already described. This fixation is not always necessary in the treatment of older subjects.

It should be stated that when the deformity is of long standing, it may be impracticable to fix the head at first in the overcorrected position, because of the impairment of the circulation or because of the discomfort that it causes.

ACQUIRED TORTICOLLIS.—As has been stated, acquired torticollis is far more common than the congenital form. At least eighty per cent. of the cases begin during the first ten years of life.

The deformity may be divided into two main groups, the common form or so-called acute torticollis and the irregular forms.

Acute torticollis is a painful contraction secondary to injury or disease of the muscles, or to irritation of the peripheral nerves. As a rule, the sterno-mastoid and trapezius muscles are involved, but occasionally other muscular groups are affected. A common form of torticollis is the so-called rheumatic or stiff neck, in which the muscles of the neck are stiff and sensitive to pressure; this form hardly requires consideration.

By far the most important form of acute torticollis is that which often follows irritation of the peripheral nerves in the naso-pharynx or its neighborhood; thus it is often a sequel of tonsillitis, measles, diphtheria, and the like. It may be preceded by toothache or earache, and it is often accompanied by enlarged or suppurating cervical glands. The onset of the affection is gradual, often preceded by fever, and the head gradually assumes the characteristic attitude of the affected muscles, and is fixed by the tonic contraction of the affected muscles. Attempts to overcome the deformity cause great pain, as do ungarded movements. It is particularly difficult to place the head in a comfortable position when the child lies down; thus "getting the child to bed" is a troublesome task.

The patients often become extremely nervous, and it would appear that the affection is more common among children of the nervous type. As has been stated, the deformity is usually typical, the muscles affected being the trapezius and the sterno-mastoid. In rare instances the contraction may affect both sterno-mastoid muscles, so that the head is drawn forward and downward between the shoulders; or the posterior muscles may be involved and the head is drawn backward, so-called

posterior torticollis. The muscles and other tissues become shortened. The pain and discomfort finally disappear and the case becomes one of chronic torticollis, although in the milder forms spontaneous recovery is possible.

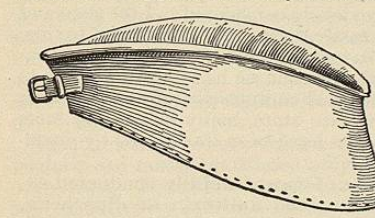*Treatment.*—The treatment is symptomatic and preventive. Support is always indicated. As an immediate application the neck may be enveloped in a heavy muff-like collar of cotton; this should reach from the shoulders to the ears, and should be of such thickness as actually to support the head. It is held in position by circular bandages, and it may be stiffened by layers of adhesive plaster. This provides heat and fixation, and for the early cases it is often an efficacious remedy.

FIG. 4740.—The Thomas Collar. This apparatus is of service in the treatment of the milder cases of acute torticollis.

In most instances a more comprehensive support is indicated. Such a support is afforded by the plaster jacket and the jury mast; the elastic tension of the halter, if properly applied, will eventually overcome the spasm, and in great degree at least correct the deformity. This correction is further assisted by massage and by gentle manipulation of the head. When the spasm and deformity have been overcome, exercises to restore the ability of the weakened muscles may be employed. This treatment is particularly efficacious in those cases in which the muscular substance is involved by suppurating cervical glands. The duration of the treatment may be from several weeks to several months. If the deformity has persisted for more than six months operative treatment after the method described is, as a rule, indicated. It is evident, of course, that if acute torticollis is of secondary origin all sources of possible irritation should be looked for and treated if found; also that the general condition of the patient should receive attention.

IRREGULAR FORMS OF TORTICOLLIS.—*Spasmodic Torticollis.*—This is a form of convulsive spasm of the muscles of the neck resembling somewhat in its general characteristics writer's cramp. It is essentially an affection of adult life and is more common in individuals of a neurotic type. The onset is usually gradual, the first indications being sensations of stiffness and discomfort, drawing sensations, and twitchings of the head. When the affection is established there are at intervals spasmodic contractions of the affected muscles, which draw the head with a jerking motion into the attitude of extreme deformity. The spasm then relaxes, to recur at frequent intervals. These contractions may be painless, but in many instances the sensation is cramp-like. After a time deformity persists, the affected muscles becoming hypertrophied and structurally shortened.

Etiology.—Little is known of the etiology. Many of the patients present a neurotic family or personal history, and in certain instances constant or constrained attitudes in occupation, defective eyesight, and the like apparently induce the affection. There is little tendency toward spontaneous recovery.

Treatment.—The general condition of the patient should receive attention, and predisposing causes, such as occupation, should be avoided if possible. In mild cases massage, systematic exercise, and in some instances support in the form of a collar or light metallic brace may be of service. In confirmed cases resection of the nerves that supply the affected muscles seems to be the most effective remedy.

If the spasm is confined to the sterno-mastoid and trapezius muscles removal of a portion of the spinal accessory nerve may be sufficient. An incision is made along the anterior border of the sterno-mastoid muscle

from the mastoid process to a point about one inch beyond the angle of the jaw. One then exposes by blunt dissection the transverse process of the atlas, which lies directly below the mastoid process. This is a valuable landmark because the spinal accessory nerve usually passes directly over it, or slightly in front of its most prominent part. Traction on the muscle will usually make the nerve more prominent. If it is not readily found its position may be ascertained by drawing the finger nail across the bottom of the wound, a sharp contraction following pressure on the nerve. This having been isolated, a section, at least an inch long, should be removed. If the sterno-mastoid muscle is actually shortened, it should be divided and a portion of the trapezius also, if this resists the correction of the deformity. Fixation of the head is, as a rule, not required after the operation. In many instances the muscular spasm involves the other muscles of the neck. In such cases resection of the posterior branches of the upper cervical nerves, in addition to the complete division of the contracted parts, may be required.

In the ordinary operation an incision, about three inches in length, is carried downward from the occiput, parallel to and about one inch from the spinous processes. It is continued through the trapezius and complexus muscles, exposing the posterior branches of the nerves. Those of the three upper nerves are then resected. As has been stated, complete division of the muscles that are shortened accompanies the operation.

OTHER FORMS OF IRREGULAR TORTICOLLIS.—*Paralytic Torticollis.*—One or more of the muscles of the neck may be paralyzed, most often the result of an extensive anterior poliomyelitis. Isolated paralysis of the muscles is uncommon.

Diphtheritic Torticollis.—Paralysis of muscles may be a sequel of diphtheria, the trapezii muscles being most often involved. This allows a forward droop of the head. The diagnosis is usually apparent.

Posterior Torticollis.—The most common form of posterior torticollis is the so-called cervical opisthotonos which is often a symptom of cerebro-spinal or basilar meningitis. A slight degree of the same deformity is not uncommon in ill-nourished infants.

Rachitic Torticollis.—In the progressive stage of rachitis, in which the characteristic kyphosis is present in the lower part of the spine, the head may be tilted backward in compensation. Occasionally the attitude may be increased by slight spasm of the posterior muscle.

Ocular Torticollis.—In rare instances the head may be carried habitually in an attitude of lateral distortion to accommodate defective vision. This is, however, rather an improper attitude than a symptom of torticollis. The treatment of these uncommon and as a rule unimportant varieties of deformity does not require especial consideration.

Royal Whitman.

TOUCH. See *Skin, Functions of.*

TOXINS, TOXALBUMINS.—Toxins are poisonous synthetical products of bacterial growth.

The exact composition of toxins has not as yet been discovered, but it is believed that they are of proteid character. At first all the toxins were supposed to be albumins, but recently some of the most important, such as those produced by the tetanus and diphtheria bacilli, have been shown to possess characteristics which separate them from that class. Toxins are formed during the growth of bacteria in media containing no proteid, but more abundantly when it is present. Toxins are divided into extracellular and intracellular poisons. Thus, the toxins produced by the diphtheria and tetanus bacilli during their growth in the tissues or culture media are largely given up to the culture fluid, but little remaining in the bacterial protoplasm, while the toxins elaborated by the typhoid, tubercle, glanders, and colon bacilli, and indeed by the majority of parasitic and saprophytic bacteria, are largely retained in the bodies of the bacteria until their death and destruction.

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Among the properties of the extracellular toxins are the following: They are so far as known uncrystallizable, and this differ from ptomaïns; they are soluble in water and they are dialyzable; they are precipitated along with proteids by concentrated alcohol, and also by ammonium sulphate; if they are proteids they are either albumoses or allied to the albumoses; they are relatively unstable, having their toxicity diminished or destroyed by heat (the degree of heat, etc., which is destructive varies much in different cases). Their potency is often altered in the precipitations practised to obtain them in a pure or concentrated condition, but among the precipitants ammonium sulphate has little if any harmful effect. Regarding the intracellular toxins which are more intimately associated with the bacterial cell we know much less, but it is probable that their nature is similar, though some of them at least are not so easily injured by heat, e.g., in the case of the product of tubercle bacilli. In the case of all toxins the fatal dose for an animal varies directly with the species, body weight, age, and other conditions as to, e.g., food, temperature, etc. In estimating the minimal lethal dose of a toxin these factors must be carefully considered.

The following is the method usually employed for obtaining concentrated extracellular toxins. The toxic fluid is placed in a shallow dish, and ammonium sulphate crystals are well stirred in till no more dissolve. Fresh crystals to form a bank nearly equal to that of the whole fluid are added, and the dish is set in an incubator at 37° C. (98.6° F.) over night. Next day a brown scum of precipitate will be found floating on the surface. This contains the toxin. It is skimmed off with a spoon, placed in watch-glasses, and these are dried in vacuo and stored in the dark, also in vacuo, or in an exsiccator containing strong sulphuric acid. For use, the contents of one are dissolved up in a little normal saline solution.

The comparison of the action of bacteria in the tissues in the production of these toxins to what takes place in the gastric digestion has raised the question of the possibility of the elaboration by these bacteria of ferments by which the process may be started. It would not be prudent to dogmatize as to whether the toxins do or do not belong to such an ill-defined group of substances as the ferments. It may be pointed out, however, that the essential concept of a ferment is that of a body which can originate changes without itself being changed, and no evidence has been adduced that toxins fulfil this condition. Another property of ferments is that, so long as the products of fermentation are removed, the action of a given amount of ferment is indefinite. Again, in the case of toxins no evidence of such an occurrence has been found. A certain amount of a toxin is always associated with a given amount of disease effect, though a process of elimination of waste products may be all the time going on in the animal's body. Again, too much importance must not be attached to loss of toxicity by exposure to change at such temperatures; for instance, if egg albumen be kept long enough at 55° C. nearly the whole of it will be coagulated. Such considerations suggest that the relation of toxic action to fermentation must be left an open question.

Similar Vegetable and Animal Poisons.—Within recent years it has been found that the bacterial poisons belong to a group of toxic bodies all presenting very similar properties, other members of which occur widely in the vegetable and animal kingdoms. Among plants the best-known examples are the ricin and abrin poisons, obtained by making watery emulsions of the seeds of the Ricinus communis and the Abrus precatorius (jequirity) respectively. The chemical reactions of ricin and abrin correspond to those of the bacterial toxins. They are soluble in water, they are precipitable in alcohol, but being less easily dialyzable than the albumoses they have been called toxalbumins. Their toxicity is seriously impaired by boiling, and they also gradually become less toxic on being kept. Both are among the most powerful poisons known, ricin being the more fatal.

It is also certain that the poisons of scorpions and of poisonous snakes belong to the same group. The poisons derived from the latter are usually called venins, and a very representative group of such venins derived from different species has been studied. To speak generally, there is derivable from the natural secretions of the poison glands a series of venins which have all the reactions of the bodies previously considered. Like ricin and abrin, they are not so easily dialyzable as bacterial toxins, and therefore they have also been classed as toxalbumins. While up to the present we have not been able to discover the exact chemical composition of any toxin, or even to obtain it in a pure state, many interesting facts upon the nature of toxins have been discovered by physiological methods.

From a large number of most carefully conducted experiments with the toxin and antitoxin of diphtheria, Ehrlich has formulated a theory concerning the constitution of the former. This theory has undergone several modifications since it was first proposed, and it is difficult to give an exact statement of it as it now stands. However, we will attempt to state in condensed form its essential points as follows:

Toxins and antitoxins neutralize one another after the manner of chemical reagents. The chief reasons for this belief lie in the observed facts: (a) that neutralization takes place more rapidly in concentrated than in dilute solutions; and (b) that warmth hastens and cold retards neutralization. From these observations Ehrlich concludes that toxins and antitoxins act as chemical reagents do in the formation of double salts. A molecule of the poison requires an exact and constant quantity of the antitoxin in order to produce a neutral or harmless substance. This implies that a specific atomic group in the toxin molecule combines with a certain atomic group in the antitoxin molecule.

The toxins, however, are not simple bodies, but easily split into other substances which differ from one another in the avidity with which they combine with antitoxin.

These derivatives Ehrlich calls prototoxins, deuterotoxins, and tritotoxins.

All forms of toxins are supposed to consist of two modifications, which combine in an equally energetic manner with antitoxin or with suitable receptors in the cells, but differ in their resistance to heat and other destructive agents.

The less resistant form passes readily into a toxoid substance which has the same affinity for the antitoxin or the cell receptors as the original toxin, but is not poisonous. The facts observed, Ehrlich thinks, are best explained on the supposition that the toxic molecule contains two independent groups of atoms, one of which may be designated as the haptophorous and the other as the toxophorous group. It is by the action of the haptophorous group that toxin unites with antitoxin or the sensitive cell molecule.

The toxophorous group is unstable, but after its destruction the molecule still unites with the antitoxin or the sensitive molecule through its retained haptophorous group.

Specific antitoxins can be produced not only with toxins but with toxoids.

Bordet believes, in contradistinction to Ehrlich, that toxin unites in different multiples with antitoxin, so that the toxin molecule may have its affinities slightly, partly, or wholly satisfied by antitoxin. Slightly satisfied, it is still feebly toxic; combined with a larger amount of antitoxin it is not toxic, but still may, when absorbed into the system, lead to the production of antitoxin. Fully saturated, it has no poisonous properties and no ability to stimulate the production of antitoxin.

The most important of the extracellular toxins are those produced by the diphtheria and tetanus bacilli. These are very powerful. 0.0000001 gm. of the dried filtrate of a tetanus culture will frequently kill a white mouse, while one-tenth of that amount of dried diphtheria filtrate has killed a guinea-pig.

According to Madsen and Ehrlich the specific tetanus

poison consists of two toxins, tetanospasmin and tetanolysin. To the first of these the tetanic convulsions are due, while the second has a hæmolytic action.

When the tetanus toxins are placed in the blood tetanolysin largely combines with the blood, while the tetanospasmin combines with the nerve cells. Each of these substances produces in animals a specific antitoxin. To obtain diphtheria and tetanus toxins for injection in animals the bacilli are grown in slightly alkaline beef broth for from seven to ten days. The broth is then filtered and preserved. Tetanus toxin is produced under anaërobic conditions, diphtheria toxin under free access of oxygen.

The bacterial poisons which reside in the bodies of the bacteria are mostly extracted only after the death of the organisms. Here in the invaded animal the disease effects are more closely associated with the actual presence of the bacteria in the vicinity than in the case of the extracellular toxins. Antitoxic sera, prepared from injecting animals with the filtrates of these bacteria, do not produce marked immunity in injected animals to infection with the living bacteria.

Tuberculin and mallein are mixtures of the bacterial poisons produced by the tubercle and glanders bacilli. Tuberculin is prepared from a fully developed culture of tubercle bacilli grown on meat broth containing five per cent. of glycerin. This is evaporated to one-tenth of its volume over a steam bath. Injected into tuberculous animals it causes a marked reaction in the infected tissue with constitutional disturbances and a rise of temperature.

Mallein is prepared in the same way from old cultures of the glanders bacillus. Injected into animals infected with glanders, it causes swelling and heat in the healthy tissues into which the mallein has been injected. Marked general disturbance and a rise of temperature of 3° to 5° F. usually follow. Typhoid, dysentery, colon, and many other bacilli and cocci contain intracellular toxins.

William H. Park.

TRACHEOTOMY.—(*Bronchotomy, Laryngotomy, Thyrotomy*, etc.) The term tracheotomy is used in general to signify an opening made from without into the windpipe in any part of its course. The term bronchotomy, originally and more properly used in this sense, has gradually fallen into disuse, and is now rarely met with. The term tracheotomy, in its exact sense, is applicable only to an opening made into the trachea proper; while thyrotomy, cricotomy, and laryngotomy, singly or in combination, may be used to describe openings made into the larynx only, and laryngo-tracheotomy and cricotracheotomy those involving both larynx and trachea.

INDICATIONS.—The object of a tracheotomy may be either to furnish a new aperture for the respiratory current, when the natural one is no longer sufficient, or to afford access to the interior of the tracheal canal for local therapeutic purposes, or for the removal of foreign bodies lodged within it. In these cases it is a remedial measure. In addition, it may be indicated also as a preventive measure, as a preliminary to some surgical operations involving the cavity of the nose, pharynx, or larynx, to render possible tamponade of the larynx, and to facilitate the administration of anæsthetics.

Any affection, laryngeal or supralaryngeal, which is causing or threatening asphyxia, is an indication for remedial tracheotomy. These conditions may be classified into: (1) Traumatic conditions; (2) inflammatory conditions; (3) neuroses; (4) neoplasms.

Some consideration of each of these classes is necessary:

I. TRAUMATIC CONDITIONS.—The first under this head come *wounds of the larynx*. When, as the result of such a wound, blood is flowing abundantly into the trachea, and hæmostasis by ordinary means cannot readily and speedily be accomplished; also, when the wound has partially severed the epiglottis so that it falls upon and occludes the glottic orifice—in these cases immediate opening of the trachea is imperative. Tracheotomy may

also become necessary later in the history of a wound of the larynx in consequence of infiltration of the submucous laryngeal connective tissue, and of the epiglottic folds, by blood, serum, pus, or air, causing the symptoms of œdema glottidis. Glottic emphysema, demanding tracheotomy, may be caused by extension of a general emphysema of the neck, when inadequate means to relieve such emphysema have been employed, but it is more frequently a localized air infiltration of the arytenoepiglottic folds from a penetrating wound of the larynx with contracted external opening. Local scarifications of the tumefied tissues, whether caused by fluid or by air infiltration, practised through the mouth, may suffice to afford relief in some cases, when time and opportunity can be had for them; but in all cases in which the suffocative symptoms are urgent, or the conditions are not favorable for making such local scarifications, immediate tracheotomy should be done. In these cases it would also be justifiable for a person provided with the necessary instruments, and skilled in their use, to try intubation after the method of O'Dwyer.

Burns of the larynx and pharynx, the result of swallowing hot fluids or caustic agents, or of the inhalation of steam, are liable to be followed by œdema sufficiently great to require tracheotomy.

Fractures of the larynx are likely to involve conditions making tracheotomy necessary. Displacement of the cartilages may in itself produce sufficient occlusion to become an indication. Consecutive œdema may result, as in the case of incised and punctured wounds of the larynx above considered; phlegmonous purulent infiltration is likely to develop; blood infiltrations are to be expected; in some instances paralysis of the glottic dilators, from injury to the laryngeal nerves or their compression by displaced cartilages or inflammatory effusions, may supervene—any of these conditions indicate tracheotomy.

Cicatricial contractions may result from loss of substance attending any of the above-mentioned traumatisms of the larynx, and may produce stenosis of a high degree. More or less occlusion may also result from adhesions between soft parts following the cicatrization of wounds of the larynx or trachea, and from the healing in abnormal situations of displaced cartilaginous fragments or flaps of soft tissue. In either of these conditions tracheotomy is indicated as soon as any considerable embarrassment in breathing is experienced; it serves both for the relief of the dyspnœa and to facilitate measures for the dilatation of the stricture. Intubation may, however, be substituted for tracheotomy in some of these cases.

In all cases of *foreign bodies in the air passages* in which suffocative symptoms present, and are urgent or frequently recur, and in which the foreign body cannot be speedily and readily removed through the mouth, immediate incision of the trachea is imperative. In a very large proportion of cases the first violent spasms of dyspnœa provoked by the entrance of the foreign body soon subside and a period of calm follows, which may, indeed, last indefinitely. To be able to operate during such a period of calm is highly desirable, for it can then be done with deliberation and with proper attention to those precautions which will prevent the operation itself from adding any new dangers to those already present. The present absence of urgent symptoms should not induce the surgeon indefinitely to postpone operation, in the hope that spontaneous expulsion may occur, notwithstanding the frequent instances in which such spontaneous expulsion is finally effected, for the foreign body is a constant menace to life as long as it remains in the air passages, and is liable to produce sudden death at any time, even in the act of expulsion. Should the dangers of death by asphyxia be escaped, the later development of localized infective disturbances from the presence of the foreign body is inevitable.

Asphyxia from the abundant *entrance of blood, vomited matters, or fluids of any kind into the air passages* calls for tracheotomy and artificial respiration, together with the

use of means to free the air passages from the foreign matter that embarrasses the respiration. Asphyxia from the entrance of blood is always to be guarded against in the course of operations about the cavities of the mouth and nasopharynx, when full anæsthesia is required, and every arrangement for immediate tracheotomy should be at hand in those cases in which a deliberate preliminary tracheotomy is not deemed advisable. A person attacked by vomiting while in a state of unconsciousness is in great danger that portions of the vomited material may enter the air passages. The accident of being drowned in one's own vomit is by no means infrequent. It is to be watched for in all cases in which general anæsthesia is induced, and when it occurs demands immediate incision of the trachea and the quick employment of energetic means to free the air passages from the obstructing material. The incision into the trachea not only supplies a new, more direct, and free opening for the entrance of air and facilitates the emptying of the air passages by the compressions used in carrying on artificial respiration, but it affords an opportunity readily to introduce instruments for cleansing the passages. Little can be accomplished in such cases by suction through tubes of any kind; but, by the forcible blowing of air into the lungs through a catheter or other suitable tube introduced through the tracheal wound, the ejection of fluids and semisolids from the air passages by the return current of air may be quickly and readily accomplished.

II. INFLAMMATORY CONDITIONS.—Stenosis of the larynx of such severity as to demand tracheotomy may arise in the course of any of the inflammatory conditions to which the larynx is subject.

In the course of an attack of *acute catarrhal laryngitis*, the rapid development of symptoms of severe dyspnœa, which are not relieved by an emetic or other antispasmodic treatment, indicates the supervention of œdematous infiltration of the aryteno-epiglottic folds and of the epiglottis. The suffocative symptoms produced by this condition may early become so immediately urgent that no opportunity for the use of ordinary therapeutic means is presented, and prompt surgical interference is the only possible thing that can avert a speedily fatal issue. In other cases a more gradual development of the œdema gives time for the employment of remedies, and many of these cases, though in great apparent danger for some time, ultimately end in spontaneous recovery.

Scarification of the supraglottic œdematous tissue has been successful in relieving some of these cases, and in yet others intubation has likewise sufficed to avert danger. But tracheotomy must remain the resource most frequently available to the practitioner who may neither himself have the special technical dexterity in throat manipulations required satisfactorily to practise the last-mentioned operations nor be able to call to his aid others who may have it.

The results of tracheotomy, when done for the relief of acute inflammatory occlusion of the glottis, are very encouraging, and, when the operation is done with the precautions and after-cares to be described further on, very little, if any, additional hazard is added to the case by its employment.

In acute laryngitis the parts below usually remain comparatively unaffected, and after the relief to the obstructed respiration has been afforded by the tracheal incision, the laryngeal inflammatory swelling so quickly subsides that the tube need be retained but a few days. The operation itself contributes to the shortening of the primary laryngitis by putting the affected parts at rest, and removing the source of irritation existing previously in the to-and-fro respiratory current.

The question of chief importance to the physician who is charged with the responsibility of the care of an acute laryngitis is, What degree of urgency must the suffocative symptoms attain to justify him in opening the trachea? He certainly should not wait until the patient is *in extremis*, nor should he be precipitate in action, for spontaneous recovery from very threatening conditions is not rare. At the same time, he is not to consider so much

the idea as to whether the patient may not possibly recover without operation as he is to decide whether his chances of recovery will be made greater by the operation.

Tracheotomy is to be accepted as one of the therapeutic resources at the command of the physician for the relief of dyspnœa from laryngeal obstruction, and when the dyspnœa is sufficiently great and prolonged to produce serious suffering, or much exhaustion, the operation is justifiable. The personal element of the skill and experience in the operation of the physician himself must also come into the equation, for, if the dangers inherent in the operation are great, it would be improper to subject a patient to them unless the dangers that were to be averted by the operation were already unmistakably greater and more imminent. Tracheotomy, while often a simple procedure, at times develops conditions that tax to the utmost the coolness, adroitness, and command of resources of the most experienced surgeon. One who is thoroughly provided to control these difficulties would be justified in offering the operation as a means of relief in circumstances less urgent than one without these qualifications.

Loss of voice, frequent thin, metallic, muffled cough, difficult inspiration and prolonged expiration, the suprasternal and epigastric tissues sinking in at each inspiratory effort, great restlessness, suffusion of the face with bluish lips—these are symptoms that, if continued, will produce speedy exhaustion; but in many cases of acute catarrhal laryngitis much of this respiratory difficulty is due to glottic spasm, which may be controlled by treatment, or may spontaneously disappear. If the severe symptoms of dyspnœa are intermittent, if they are lessened in severity and in frequency by treatment, if the general prostration is not great, and if the lethargy denoting advancing defective oxidization of the blood is not marked, tracheotomy should be deferred.

When, on the other hand, the dyspnœa is continuous, and is gradually and steadily increasing despite treatment, especially when symptoms of exhaustion are developing —as shown by pallor of the face, with cold perspiration— and when the benumbing effects of defective aëration of the blood are manifesting themselves—as shown by a tendency to lethargy replacing previous restlessness—then tracheotomy should be resorted to without further delay.

Pseudomembranous Laryngitis.—Of all the causes which may possibly determine dyspnœa of sufficient gravity to require tracheotomy for its relief, the accumulation of a membraniform exudate upon the surface of the laryngeal mucous lining is the most frequent. When the accumulation of such a laryngeal exudate is secondary to, or synchronous with, the same formation within the pharynx or upon the tonsils, early recognition of the cause of the laryngeal symptoms is made; when the earliest manifestation of the exudate is within the larynx, a not infrequent occurrence, the condition cannot be distinguished with certainty from that attending acute catarrhal laryngitis in its severer forms; it is only when, in the progress of the case, membraniform fragments become detached and are expectorated, or a membraniform exudate forms in the pharynx or fauces also, or the presence of the exudate is demonstrated by incising the trachea, that an absolute diagnosis can be made. It is a common error to assume that severe and continuous dyspnœa arising in the course of acute inflammatory affections of the larynx is due to a membraniform exudate, and to denominate the case "membranous croup." This assumption has given rise to many erroneous conclusions as to the value of medicinal treatment in cases of so-called membranous croup, for the catarrhal inflammation is much more amenable to medicinal agents than is the exudative. As long, however, as any doubt about the exact character of the case exists, it is wiser, from the standpoint of treatment, to assume that the more intractable disease is present and to guide the treatment accordingly. Such a principle of action will lead to an earlier resort to tracheotomy than would otherwise be the case. If the practitioner has positive evidence, or provisionally

accepts the conclusion, that the larynx is becoming blocked by membraniform exudate, his course of action will also be likely to be influenced by his opinion as to the diphtheritic or non-diphtheritic character of the exudative process.

As to the possibility of the development, upon the surface of the laryngeal mucous membrane, of a membraniform exudate not due to diphtheritic infection, there is considerable evidence, consisting chiefly in the undoubted occurrence in localities of cases of membranous laryngitis at rare intervals during a long period of years before the prevalence of diphtheria in that locality.

If such non-diphtheritic cases formerly occurred they may doubtless still occur; but abundant observation has demonstrated that, clinically, it is impossible to distinguish such cases at the present time, and that the symptoms tabulated by systematic writers for establishing the differential diagnosis between the two classes of cases are entirely unreliable, and their importance quite imaginary. The occurrence of membranous laryngitis in any community at the present time is always associated with the prevalence of some other forms of diphtheria.

Practically all considerations as to the treatment of pseudomembranous laryngitis resolve themselves into that pertaining to laryngeal diphtheria, and as such I shall consider them in what I may have to say further. The proportion of recoveries from laryngeal diphtheria, without tracheotomy, was exceedingly small, less than ten per cent., before the introduction of the use of diphtheritic antitoxin in the treatment of diphtheria. Present experience indicates that fifty per cent. of such patients may now be expected to recover under the antitoxin treatment without operative interference. The addition of intubation has still further reduced the mortality, so that now about two-thirds of intubated, antitoxin-treated cases end in recovery. The proportion of recoveries in tracheotomized-antitoxin-treated cases is about the same. Of 5,004 intubation-antitoxin cases gathered by Siegert from the records of hospitals for children on the continent of Europe for the period 1890-98 the mortality was 32.4 per cent.; of 6,942 tracheotomized-antitoxin cases the mortality was 32.5. Since, however, tracheotomy is usually resorted to in a more severe class of cases, and at a later date than is intubation, the therapeutic value of tracheotomy would seem to be distinctly greater than that of intubation, which should be preferred only in cases of slight intensity, in cases in which the special cares required after tracheotomy cannot be secured, as well as in those in which the consent of parents to tracheotomy cannot be gained.

The progress of a case from the first inception of symptoms of hoarseness and slight embarrassment of breathing to the termination in death is usually rapid. Out of 1,760 cases of fatal croup in the city of Brooklyn, in children less than five years of age, 57 per cent. died within three days from the onset of the croupy symptoms, 159 died within twenty-four hours, and 22 died within twelve hours. Much time for deliberation is therefore not to be relied upon.

In addition to the exhaustion produced by the unintermitting violent efforts to respire, the deficient blood oxygenation, and the continued depressing effect of the diphtheritic poison, the surgeon must also take into consideration the damage likely to be inflicted upon the lungs themselves during prolonged unrelieved dyspnœa. Pulmonary emphysema and œdema, and diffused capillary hyperæmia, with subsequent bronchial catarrh, result from prolonged dyspnœa, and from complications hindering recovery, should the dyspnœa finally be relieved by tracheotomy. Tracheotomy tends to prevent death in diphtheritic laryngitis by making possible free access of air to the lungs, and thus: (1) Relieving or preventing carbonic-acid poisoning and its sequelæ; (2) supplying the blood freely with the best of stimulants and tonics—oxygen—by which act it assists in the struggle to eliminate the special blood poison, and favors the limitation of the disease; (3) at once ending the cupping-glass action exerted upon the whole surface of the re-

spiratory tract below the larynx by the inspiratory struggles, a result which lessens the danger of the occurrence of diffuse catarrh of the air passages, of pneumonia, and of pulmonary œdema, and promotes recovery from these conditions when not already too extensively developed; (4) rendering respiration free and easy, in consequence of which exhaustion from excessive muscular exertion is either prevented or—if already present—is in some measure relieved.

It tends to prevent death by eliminating from the possible causes of death œdema glottidis, and occlusion of the glottis by a piece of loosened membrane, through the establishment of an opening for the entrance of air at a point between the glottis and the lungs. It prolongs life, and thus gives increased opportunity for the action of remedies, and for a rallying of the powers of nature sufficient to throw off the disease.

By tracheotomy the surgeon is given ready access to the interior of the trachea, and is enabled to remove at once from it any masses of detached exudate that may be present, as well as the abundant pultaceous secretion formed by the mixture of membranous débris and muco-pus which often accumulates below the membrane proper, and is liable to be sucked back into the finer bronchial ramifications, blocking them up and carrying infection to the deepest parts of the lung tissue.

Through the tracheal opening local medication of the trachea and larger bronchia is facilitated, a more direct and accessible way being provided for the introduction of sprays and solutions, forceps and swabs, as the after-course of the disease may require.

The choice of the point at which the trachea is to be opened should also be controlled by the facility with which intratracheal examination and treatment may be carried on through the incision. Without question an incision at some point below the thyroid isthmus gives the surgeon the most advantage in this respect, and for this reason should be chosen, notwithstanding that it demands more care and anatomical knowledge for its safe performance than an incision above the isthmus.

When the one indication for tracheotomy is present, viz., laryngeal stenosis to such a degree as to be a source of danger either directly or indirectly, there can be no contraindication to the operation. Whatever the degree of septicæmia, if the stenosis is great enough materially to intensify it, the operation should still be done.

Coexisting pneumonia, bronchitis, exhaustion, even apparent death, instead of contraindicating, do the more distinctly indicate it. These and other complications render the prognosis more grave, but do not justify a refusal to operate. The literature of the subject abounds in instances in which, despite the gravest complications, recovery has been secured.

Laryngeal tuberculosis, syphilitic disease of the larynx, phlegmonous inflammation of the pharynx or of other structures in the vicinity of the larynx, and chronic hyperplastic laryngitis may each produce such a stenosis of the air passages as to necessitate opening of the trachea for its relief. More rarely spasm or paralysis of the muscles of the larynx may determine a dyspnœa so serious and prolonged as to become an indication for tracheotomy.

Neoplasms may become the cause of an indication for tracheotomy either by pressure from without, as in goitre, or by blocking up the air duct from within, as in carcinoma and papilloma.

TRACHEOTOMY AS PRELIMINARY OR ADJUNCT TO OTHER SURGICAL PROCEDURES.—The preliminary opening of the trachea, and the use of appropriate means to tampon the pharynx or the trachea, and thus to prevent the entrance of blood into the air passages in the course of surgical operations involving the cavities of the nose, mouth, and pharynx, commends itself as a device of great value, and worthy of being assigned an important place in the technique of bloody and prolonged operations in the regions stated.

For a full description of the anatomy of the anterior median region of the neck the reader is referred to the