

PEASLEE (E.R.)

the

A MONOGRAPH

ON THE

Pathology and the Rational Treatment

OF

INFANTILE LARYNGO-TRACHEITIS,

OR

CROUP.

BY E. R. PEASLEE, A.M., M.D.,

PROF. OF ANATOMY, ETC.

(Sart. Coll.)

FROM THE AMERICAN MEDICAL MONTHLY.



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ALTHOUGH the readers of the MONTHLY have so recently perused the able article on Croup, by Dr. Horace Green,* the great practical importance of this subject affords a sufficient apology for again so soon calling their attention to it. Moreover, the writer of the present article desires, while Dr. G.'s views are fresh in recollection, to express his own convictions, both from experience and observation, of their correctness, so far as the mischievous consequences of the violent treatment usually resorted to are concerned; while he at the same time proposes certain ideas he has for some time held of the pathology of this disease, and thus attempts to lay a foundation for its rational treatment.

The sanguinary and heroic means generally resorted to in the treatment of croup, would seem to show that it is regarded as essentially different from all other infantile diseases; and hence, the caution and regard for the delicacy of the little patient, which should characterize all medication at this period of life, has apparently been regarded as here out of place. At least, the disease has been too generally treated with an energy—a *desperation* even—which no other opinion can justify.

It is believed, however, that croup may be shown not to be wanting in analogies with other diseased conditions, both in the infant and the adult; and that some salutary, practical inferences will flow from a knowledge of the relations here to be pointed out.

* See the June No. of the MONTHLY, p. 409-421.

Two varieties of croup are admitted by all writers—the *spasmodic* and the *inflammatory*.

The *spasmodic croup*—otherwise called *false* or *spurious* croup—is merely a *laryngismus*; in other words, it is merely a spasmodic condition (a spasm) of the muscles of the larynx. It is very unfortunate that the word “croup” has ever been applied to this affection, it having but a single symptom in common with genuine croup, viz., the peculiar stridulous sound accompanying inspiration. This should hereafter be termed *laryngismus*, merely, and not croup; and by that term it will be designated in this paper.

The *inflammatory* variety of this disease (with which some degree of *laryngismus* is always associated), is called *true* croup, and sometimes membranous croup; and more recently has been termed “pseudo-membranous laryngitis.”* The last name implies two distinct propositions: 1st. That croup is a laryngitis, *i. e.* an inflammation of the mucous membrane of the larynx; 2d. That this inflammation is accompanied by the formation of a false membrane.

Here, then, are the two essential pathological elements of this disease, and without the co-existence of which, croup does not exist.† But, assuming these propositions, in order to have a definite point of departure, in discussing a subject so differently understood by different writers,—several questions at once suggest themselves.

Does laryngitis occur also in children, as in adults, *without* false membrane? And, if so, shall it not also be termed croup? On the other hand, does laryngitis *with* false membrane occur in adults? And is it *not* here true croup also? Is the actual pseudo-membranous laryngitis of infants and children a *specific* inflammation? And, in this form of disease, does the danger to the patient result mainly from the presence of the false membrane, as seems to be so very generally admitted? or is the inflammation alone often sufficient to produce fatal results?

These, and other inquiries suggested by these, will be answered as we proceed. They have all been variously answered by different writers; and hence we deem it necessary to examine them anew.

1st. Does laryngitis, without false membrane, occur in the infant as in the adult?

We may very summarily dispose of this question, by reminding ourselves that several writers admit a *catarrhal* variety of croup, in which it is con-

* Some make croup to be a *tracheitis*, instead of a laryngitis. It will be seen, however, that both these portions of the air-passages are, almost uniformly, and even the bronchi also are, not infrequently, affected in succession, or at the same time, in this disease.

† M. Bouchut says, “Sans ce produit [fausse membrane] il n’y a pas de croup.”
§ Guertent and Bretonneau hold the same idea.—*Dr. H. Green on Croup*, p. 5-7.

fessed that no false membrane is formed. But a mere *catarrh* is an increased secretion from a mucous membrane, from congestion or irritation, or both, and is no evidence of inflammation at all. True membranous croup is often preceded by a mere catarrh of the larynx and trachea; and a catarrh often stops short of true croup. But to term a mere catarrh of the upper part of the air-passages in a child *croup*, while we at the same time admit its inflammatory character, is as objectionable as to term an increased secretion of the Schneiderian membrane (as from the irritation of snuff) an inflammation of this part. And the absurdity of this idea is still further shown, if we decline to term a similar catarrh "croup," when it occurs in the adult; and moreover, hold, with some, that this same catarrh is, in the child, the result of a peculiar—a *specific* inflammation.

If there be an actual inflammation, there will in all cases be something different upon the membrane from a mere catarrh. This will be explained further on; and, meantime, we shall object to the term croup being applied to any morbid state in which inflammation is not an element.

Now, regarding croup as always an inflammation, all well know that in fatal cases of true croup, so called, the development of the membrane is not always completed before death ensues. But all analogy favors the presumption that a laryngitis may run through its course and terminate favorably in the infant as well as in the adult, without necessitating the formation of a false membrane in any degree. Inflammations of even the serous membranes are not uniformly productive of false membranes, in either infants or adults; indeed, they are so only in a minority of all the cases. Highly improbable is it, therefore, that inflammation of the mucous membrane of the infant's larynx should always produce a false membrane.

And does it alter the case, if we admit, with some, that croup is a specific inflammation? Not at all, as we shall see when we come to explain the manner in which a false membrane is invariably produced.

Or we are, perhaps, assured that croup is an inflammation mainly of the mucous follicles of the larynx and trachea, and therefore the false membrane is developed. We cannot conceive how, in any case of laryngitis, these follicles can possibly escape the inflammatory process, if we consider either their number or their position. But how they are more likely to be especially attacked in the infant than in the adult, or, if so, why they are in the former more likely to lead to the formation of a false membrane, none of the received principles or analogies of pathology can explain.

Are we told that these follicles when inflamed secrete an albuminous fluid, and this becomes converted into the false membrane? I reply, that the *secretion* (incorrectly so called) is *not* "albuminous," though generally so represented; and that a false membrane, moreover, is never developed from a secretion.

But if the false membrane extends into the trachea, it is found to be thickest on the posterior wall, where the follicles are most abundant. Precisely so; and the true explanation of this fact will be given further on.

Others, still, assert that the false membrane is produced from the fact, that the submucous areolar tissue is inflamed in membranous croup. This, however, is an entirely gratuitous assertion.*

The presumption is, therefore, in favor of a laryngitis not leading to the formation of a false membrane, in the infant as well as in the adult.

And what facts can be found to bear on this question? Do we not meet with cases of supposed membranous croup, in which recovery takes place without the existence of a false membrane having been *demonstrated* at all during the progress of the case? And in how many cases in which the membrane is said to have been coughed up, or vomited up in a "dissolved state," or in the form of "flakes," is it certain that the supposed false membrane was actually such? It is very true that children, up to nearly or quite seven years of age, usually *swallow* whatever they force up through the larynx by the act of coughing. But it is also true, that various substances ejected from the stomach of a healthy child, even, might sometimes be found precisely to resemble these "shreds" of false membrane, so called, which sometimes appear in the circumstances under consideration.

We do not, therefore, by any means deny that shreds of false membrane are often ejected from the stomach during the continuance of true croup: but we do insist that very often they could not be demonstrated to be such, especially if they had remained for a short time in that viscus; and, moreover, that very frequently they would not have been pronounced such on examination even, were they not expected, in such a case, as a matter of course. We accept, therefore, such observations, except when the fragments are distinctly tubular, or of considerable dimensions, with a degree of philosophical doubt; just as we listen to accounts of worms appearing in the alvine evacuations, "cut up" and "dissolved," after giving a vermifuge on the suspicion that they are present in the alimentary canal—though no other previous or subsequent proof of their existence can be adduced.

On the other hand, not infrequently does it occur that in autopsies of fatal cases of what was diagnosed and treated as true croup, no false membrane at all is found. Had it here become detached, and been expectorated before death? There has been no proof of this whatever.

Such facts, we think, render it extremely probable that in many cases,

* The writer by no means denies that inflammation of the submucous areolar tissue of the larynx ever exists. On the contrary, "submucous laryngitis" is a well-known disease, and œdema glottidis is a frequent result of it. But croup is another disease, according to all writers, and is here regarded as mere laryngo-tracheitis.

not distinguishable for any practical purpose from true croup, during life, a *false membrane is not formed at all*; and that, therefore, laryngitis without the formation of a false membrane occurs in the infant as well as in the adult.

But this point will be still further elucidated, when we have next considered the source from which false membranes are in all cases derived, and the manner in which they are developed.

I. A false membrane is, in all cases, formed from the *plasma of the blood*, and which consists principally of its fibrine. It was remarked, several years ago, by Dr. Alison, that there is, in all inflammations, a *tendency* to the exudation of plasma from the vessels of the inflamed part. We maintain that in all inflammations an exudation actually does occur. It is, however, sufficient for our present purpose, that the plasma is exuded from the engorged vessels of the part and upon the surface, in all cases of inflammation of membranes, at least. Nobody doubts this assertion in regard to serous membranes; and even the purulent discharge (often called a secretion) from an inflamed mucous membrane, is known to be derived from the plasma exuded by a degeneration of the exudation-corpuscles into pus cells. Moreover, if an actual false membrane forms in croup upon the mucous surface, it is equally derived from the same source.

1. The first step towards the formation of a false membrane in croup, therefore, is the exudation of plasma upon the surface of the mucous membrane, as explained, in consequence of the laryngitis. The amount of the exudation will depend upon several circumstances; of which, the state of the blood, the extent of the inflammation, and the vascularity of the part, are the most important. In membranous croup, the exudation is most abundant, and therefore the resulting membrane is thickest, on the surface where the mucous follicles are most abundant; and this, in the trachea, is the case with the posterior wall. The follicles are merely an *inversion* of the mucous membrane; so that here is a great amount of free surface, and a vast number of small blood-vessels inclosed within a very small space. In other parts, the surface is much more smooth, the vascularity less, and thus the exudation, as well as the resulting membrane, is thinner. It has already been asserted, that it is not the secretion of these follicles that becomes organized, nor is the exudation "albuminous."*

2. The second step in the development of a false membrane is the organization of the exuded plasma. But it is very well known that, in the majority of instances, this never takes place, even on serous membranes, and therefore no false membrane is formed.

* The fact observed by Hasse, that fibrous bands or threads sometimes extend from the false membrane into the follicles, is thus shown to be precisely what we should expect.

In fact, three entirely different results may ensue to the layer of plasma exuded upon the free surface of a membrane in consequence of inflammation; provided it is allowed to remain in contact with it.

1st. It may be entirely reabsorbed.

2d. It may be converted into pus; exudation-corpuscles being formed in it, and these becoming, subsequently, degenerated into pus cells.

3d. It may become fibrillated (coagulated), and thus form a false membrane; which, subsequently, may become more highly organized; and, in case of serous membranes, even vascular, at last.

Now, either of these results is possible, in case of inflammation of both serous and mucous membranes. In case of the latter, however, the part affected may be so situated as to be brought into contact with foreign substances (as is the case with the mouth, pharynx, and other parts of the alimentary canal); and the exudation may thus become at once detached, and in that case, neither of the three results above-mentioned can ensue. Moreover, the opportunities for reabsorption on mucous membranes are very slight indeed, and often null.

To illustrate these results in case of a serous membrane: In *pleurisy* the exudation being reabsorbed, perfect recovery takes place; if it becomes organized, false membranes and adhesions are the result; or if it is converted into pus, empyema is the result.

Now, the circumstances favorable to the organization of the plasma are:

1st. Its perfect contact with the living tissues;

2d. Perfect rest of the part, or maintaining the required contact, and for the necessary time also;

3d. Smoothness of surface, as also subservient to the first condition.

On the other hand, the following circumstances are unfavorable to organization:

1st. Motion of the part affected;

2d. Contact of foreign substances;

3d. Irregularity of surface.

But there are certain other conditions of the exudation itself, also, which affect the result. The former is more liable to become organized, and the membrane is more perfectly formed, in proportion—

1st. To the amount of fibrine contained in it;

2d. To the slowness (amount of time allowed) of the fibrillation.

Here we should, however, remark, that all the formative processes are in much less time completed in the young than in the adult animal; and it is in accordance with this ultimate fact, that Jurine and other experimenters could artificially produce false membranes in the air passages of young animals alone. In adult animals, the exudation would become detached before its organization was complete.

Now, if we compare the probabilities that an exudation upon a serous membrane will become organized, with those that the same result will occur upon a mucous membrane, we find the former allows—

(1st.) Of a far more perfect contact; since it is smooth, and comparatively or entirely at rest (*e. g.*, remark the immobility of the ribs in respiration, in pleurisy). (2.) It excludes the exudation from the air and from foreign substances. (3.) Allows time for the perfection of the process of organization. (4.) The fact, also, that contact of the exuded plasma with the living tissues occurs on both its surfaces at the same time (being between the two layers of the serous membrane), must not be omitted here. Nor (5) must we fail to add, that in case of inflammations of serous membranes, the blood (and therefore, probably, the exudation also) contains a greater amount of fibrine than exists in it in inflammations of mucous membranes.

Mucous membranes, on the other hand, are opposed to the serous, in all the respects just mentioned. 1. Having a conoidal instead of a delicate, scaly epithelium in most parts (*e. g.*, over the whole respiratory passages, and the alimentary canal from the cardiac orifice of the stomach to the sigmoid flexure), they do not allow of so perfect a contact of the plasma with the living tissue of the membrane itself. 2. They afford contact only on one side of the plasma. 3. In most parts, the plasma is exposed to the air and the contact of foreign substances. 4. There is more motion of the part. 5. All these circumstances afford less time for the organization to occur; so that it may fail of being completed, if commenced. 6. And, finally, the plasma itself is less organizable than in the case of inflammation of serous membranes.

We have no difficulty, then, in accounting for the fact that false membranes occur very much more frequently on serous than on mucous membranes. Nor is there any in accounting for the fact that, in certain cases, they are formed on the latter also, as well as the former.

False membranes have been known to form in cases of inflammation of the rectum, the vagina, the uterus, the nasal passages, the pharynx, larynx, trachea, and bronchial tubes; and in all these parts certain peculiarities exist, more favorable to the organization of the plasma than the mucous membrane in other parts presents. The rectum and vagina have a scaly epithelium, and are comparatively at rest—the rectum, even, being void of feces and of motion, except during the act of defecation. The uterus, also, allows of still greater rest of the exuded plasma, though it has a conoidal epithelium. The whole extent of the air passages is provided with a conoidal and a ciliated epithelium; but it has no foreign body in contact with it, except the air; and in this respect, and in point of motion of the surface, has the advantage of the alimentary canal above the rectum; where false membranes do not become organized. In children, however, there is less motion

still; and, they also requiring less time, we should expect organization to occur more frequently than in adults.

Now, to return to the subject directly under consideration.

In cases of actual laryngitis with false membrane, or membranous croup in children, the exuded plasma becomes to some extent organized—*fibrillated* at least. But can we suppose that this result occurs in every case of laryngitis in the early years of life? If the plasma is often absorbed, and also frequently converted into pus, in case of inflammation of a serous membrane (*e. g.* in pleurisy), can we doubt that either or both these results often occur in cases of inflammation of any and of all mucous membranes? And to say that croup is a peculiar or *specific* inflammation, in order to account for the formation of the false membrane, would, for the sake of consistency, compel us also to invoke a *special* inflammation in those cases of pleurisy in which adhesions occur, while a *common* inflammation will answer if recovery occurs by absorption, or if empyema ensues. Our ideas, then, of the pathology of croup, so far as the answer to the first inquiry has established them, are these:—

1st. An inflammation of the larynx, extending into the trachea occurs; offering in its essential nature nothing different from any other case of inflammation of the same parts, either in the infant or the adult. It is generally preceded, in both infants and adults, by congestion and irritation, and therefore by catarrh.

2nd. An exudation of plasma occurs on the inflamed surface, as in the adult; this being most abundant, in the trachea, on the posterior wall, for reasons already given (p. 5).

3rd. This exudation may be disposed of, in at least two ways, provided it is not at once removed, as it generally is, in adults but not in infants, by coughing; reabsorption probably very seldom occurring in this disease, though it is not impossible.

a. It may become degenerated into pus (purulent matter,) and thus, of course, at once be detached, which is the most common result.

b. It may become organized into a false membrane. This is more probable if the blood is rich in fibrine (*e. g.* in a plethoric child); if there is but little cough (an adult generally expelling it thus), and if time is allowed for its development (less being required in the child than in the adult) (p. 6).

4th. Croup is, therefore, merely a laryngo-tracheitis in infants and children, and offers nothing essentially different from the same inflammation in adults.* The exudation in case of adults is, however, usually at once ejected by coughing, or in the form of purulent matter; while the liability

* The idea of Copland and others, that the false membrane in infants is due to a greater amount of *albumen* in the blood, is entirely without support.

to its organization in infants is greater; though, after all, a comparatively rare result, considering the whole number of cases—for the reasons before mentioned.*

5th. Practically therefore, as well as pathologically, we cannot say with Bouchut, "*Without a false membrane, croup does not exist.*" This membrane never exists till the inflammation—the essential element of the disease, as we believe—has preceded, and has produced the exudation of plasma, as before shown. No sooner does the catarrhal *irritation* merge into inflammation, than the plastic lymph is thrown out;† and this *inflammation and its accompanying exudation* are the elements always present in croup.‡

We, therefore, need not, for any practical purpose, admit an "inflammatory and a membranous" croup, as some writers have done, any more than we should make the same distinction in regard to pleuritis or peritonitis. All croup is *inflammatory*, at any rate; and a few cases are also accompanied by the formation of a false membrane. But the latter should not affect the treatment of the disease as an inflammation, but merely from its mechanical effects, and cannot be predicated in any case till it is actually seen; and this is not possible in most cases in which it is developed at the very onset of the disease.

Finally, we would drop the term croup entirely, and use the term laryngo-tracheitis instead. In a work on the diseases of children, we would call particular attention to the fact that a false membrane is formed in about one-sixth of all the cases of this disease; while in adults, this is of very rare occurrence. But we would not make an accident the distinguishing feature of this disease, more than we do in the case of others, nor allow it to enter into either our name or our definition of it.

As in all other inflammations, so in this; the distinction of "sthenic" and "asthenic" is important, both in a pathological and a therapeutical point of view. So far also as laryngismus enters into any particular case—and it does into all cases of true laryngitis to some extent—the case is, of course *spasmodic*; but this term must not be applied to the exclusion of the idea of inflammation. *Genuine spasmodic* croup, we have already seen, is a mere laryngismus. There is more or less spasm in all cases of bronchitis, and still more in whooping-cough; in the latter case in the larynx also; so that infantile laryngitis does not present any peculiarity in this

* In Dr. Ware's "Contributions to the History and Diagnosis of Croup," false membrane was found in only 22 cases out of 131, or about one-sixth of the whole.

† Hasse's Diseases of Organs of Circulation and Respiration, p. 277.

‡ Dr. H. Green also holds this idea, though in different terms. See his work on Croup, p. 13.

respect. *Catarrhal* infantile *laryngitis* we regard as a contradiction of terms (p. 3).

2. Does laryngitis (and tracheitis) with false membrane occur in the adult, as in early life?

We do not hesitate to answer this question in the affirmative, having seen such membranes ourselves, and having demonstrated their fibrillated structure under the microscope. Such cases are comparatively rare, for the reasons already assigned (p. 8; *b.*); and therefore occur more frequently in females who are not accustomed, or (as in some instances) not able, to expectorate at all. I received and still retain such a membrane, expelled in a tubular form by an adult female patient of Dr. G. W. Garland, now of Lawrence, Mass.

Even "membranous croup," then, if we retain the term, occurs, though rarely, in adults, it being at all ages essentially the same disease so far as its pathology is concerned.

3. Is croup a *specific* inflammation?

Our negative reply to this question has already been anticipated (p. 8; 4th).

4. In infantile laryngo-tracheitis with false membrane, does the danger to the patient result almost entirely from the presence of the membrane, as seems to be so generally admitted? or is the inflammation alone often sufficient to produce death?

Surely no reason can be assigned why a disease so fatal to adults as laryngitis and tracheitis should not be equally so in early life. And yet, since the decease of the "Father of our country" to the present time, adults have died without the formation of a false membrane, in almost all instances, so far as can be ascertained.

The fact cannot be overlooked, that an inflammation of the larynx is a serious and a dangerous matter, at any time of life, as a mere *inflammation*, aside from the final disposal of the exuded plasma. The treatment is therefore to be directed primarily to the disease as a mere inflammation. Of course, the formation of the membrane brings a new danger to the patient, since it partially, and (if it extends to the bronchial divisions in the lungs) in some parts completely, closes the air passages, and thus produces a gradual asphyxia. Occurring, as it does, also, after the patient is reduced by the previous inflammation, its dangerous effects are increased.

But we must, however, bear in mind the fact that the membrane is not organized till the *inflammation has subsided* in the part. The inflamed vessels relieve themselves by the exudation, and thus the inflammatory process is arrested.* The treatment, therefore, to subdue inflammation, so

* "The secretion of the lymph *weakens* the inflammation most commonly, and in

proper at first, is *not* proper after the false membrane is formed in the larynx and trachea. We have here a *consequence* of inflammation to treat, in a part which the inflammation itself has left. But this point will be more definitely considered farther on. The thicker the membrane, the greater the danger and amount of asphyxia; but the small trachea of an infant being closed in a greater ratio by it than the larger tube of the adult, the danger is comparatively slight in the latter from its formation. It is seldom more than $1\frac{1}{2}$ line thick at the thickest part, in the child; and usually $\frac{1}{2}$ to 1 only. But before proceeding to apply the preceding views to the treatment of infantile laryngo-tracheitis, the following points also may profitably be briefly alluded to.

1st. The progress of laryngo-tracheitis is invariably from above downwards. The observations of the best pathologists have established this point. Generally, or at least very frequently, a catarrh commences in the nasal passages, and extends backwards into the pharynx; then, descending into the larynx, continues such for a time, or at once merges into an inflammation. Often the pharynx becomes inflamed, and a false membrane appears upon it before the inflammation descends into the larynx and trachea. In some cases the larynx may be the part first affected; but if so, such cases are to be regarded as exceptional, and the inflammation never extends upwards, but always downwards from that organ. The existence, therefore, of a catarrh for two or three days, and especially of a false membrane on the pharynx, before the peculiar ringing cough of infantile laryngitis occurs, are most important elements of diagnosis in this disease, though their absence is not *demonstrative* of its non-existence. It will be recollected, therefore, that we said the exudation of plasma relieves the inflammation of *the part*, though at the same time it may be extending downwards to other parts lower in the air passages.

2nd. In infantile laryngitis it has been stated that it progresses downwards into the trachea. In some cases (and not unfrequently) it extends into the bronchi, and even into their subdivisions in the lungs. The exudation is sometimes so copious in the smaller tubes in the lungs, that they become filled with a solid cylinder of plasma, instead of being lined with a false membrane. The same often occurs in cases of bronchitis in adults. We can have no warrant that this result will not occur in any case where a

the end puts a stop to it entirely."—*F. Ryland on Diseases and Injuries of the Larynx and Trachea*, p. 134.

Exudation always at once puts a stop to the inflammatory process in the precise part where it occurs. But it does not necessarily preclude its return in the part; and therefore, in croup, two or three membranes, it is *believed*, have sometimes formed in succession on the same surface. We, however, wait for farther proof of this assumption; though the possibility is admitted.

false membrane has been formed; nor that convalescence will commence at once, though large portions of it have been expelled from the trachea. Nor can we expect the convalescence to progress rapidly as soon as the laryngismus and ringing cough have ceased, since a bronchitis may still remain for a few days, or may even prove fatal at last.

Some seem to think that if the false membrane is removed from the larynx and trachea, all danger is over. Nothing, however, is gained by merely passing the air through the *air passages*; it must enter the *air cells*, before the blood is aerated thereby. Whether, therefore, the trachea is diminished to one-half of its capacity by a false membrane; or one-half of the smallest bronchial tubes are completely closed by solid cylinders of plasma, will not make the least difference so far as the production of asphyxia is concerned.

3rd. The false membrane is often formed in a very short time after the exudation is ~~found~~ out (see the conditions, p. 6); but it is an important fact that a false membrane formed on a mucous surface never becomes vascular, and therefore permanent, as it may on a serous membrane; but it *soon becomes detached, and spontaneously falls off*. This is well known to be the case in vaginitis and the endo-metritis which sometimes accompanies dysmenorrhœa; and the disease now under consideration is not at all different from these in this respect. Only a fibrillation existing in the false membrane, and therefore no vascular connection between it and the subjacent surface, it soon loses its slight vitality, and is cast off accordingly.

The time elapsing before the spontaneous detachment of a false membrane varies in different cases; but seldom exceeds five or six days after its formation. But this result will surely occur, if the patient's strength continues, and thus life is sufficiently prolonged to afford the necessary time.

4. It has been seen that laryngo-tracheitis occurs in the adult as well as in the infant; but is not the "Diphtherite" of M^r. Bretonneau a different disease?

We see no necessity for any such admission. In diphtherite, the false membrane, almost always covers the pharynx and tonsils, and often extends into the posterior nares, covering both surfaces of the velum; and then descends into the larynx and trachea. The same often occurs also in connection with scarlatina and rubeola.

But all this also, often occurs in the young child, and therefore the terms "Diphtherite," or "Croup of Adults," we consider objectionable, as calculated to foster the idea of a radical difference as to the nature of inflammation of the larynx and trachea in the young child and the adult, while they are pathologically the same. To say that this is an "exudative inflammation" of the parts affected, is tautology; since all inflammations of membranes are accompanied by an *exudation* at least, as already shown.

Diagnosis of Infantile Laryngo-Tracheitis.

While it is in the highest degree important that a correct diagnosis be formed early in the course of this disease, it must also be acknowledged that this is often a matter of the greatest difficulty. We are, however, decidedly of the opinion that if the usual "perturbating" treatment of the disease is to be carried into execution, the little patient's prospects of ultimate recovery will, in most cases, be at least as good if we commit the mistake of deciding that the disease does *not* exist when it actually does, and thus give the patient the chance of recovery without any medication at all, as if we err in the opposite direction, and therefore apply the treatment though there is no serious disease at first.

In a suspected case, therefore, we would assume that this disease does not exist, till some positive reasons appear for the opposite conclusion.

The question is usually between laryngo-tracheitis on the one hand, and mere laryngismus or catarrh on the other. The general differential diagnosis of these three pathological conditions, may be expressed as follows:

<i>Laryngismus.</i>	<i>Catarrh.</i>	<i>Laryngo-tracheitis.</i>
Attack sudden.	Ditto gradual.	Ditto gradual, and often preceded by catarrh.
Usually attacks delicate and irritable children.	Attacks children of all conditions.	Most frequently attacks robust children.
Is an affection of the spinal (diastaltic) nervous system.	Is an irritation and congestion of the mucous membrane	Is an inflammation of the membrane affected.
Neglected, the attack may pass into general convulsions.	Neglected, may be transient; or, inflammation may ensue.	Neglected, recovery may, after several days, occur; less probably in the membranous form.
Is no fever.	No fever usually at first.	Constant febrile symptoms.
Attack sudden; cessation ditto.	Progress and decline gradual.	Ditto ditto.
Eyes unaffected; no sneezing, or discharges.	Suffusion of the eyes; sneezing and discharges more or less copious and acrid.	These symptoms generally precede for two or three days the development of laryngo-tracheitis.
Cough absent during intervals of attacks; seldom croupal during them.	Cough persistent, short, frequent, and harassing; not croupal.	Cough persistent, and peculiar—"croupal."
Respiration free in the intervals; often stridulous during attacks; no uneasiness in air passages during intervals.	Respiration hurried; tickling or relaxation in the throat; redness and tenderness in the fauces.	Respiration has peculiar sound; inspiration being "stridulous." Fauces injected <i>at least</i> .
Voice unchanged in the intervals.	Voice hoarse; uneasiness and tightness of the chest.	Voice husky or lost, continuing so constantly.
No false membrane on the fauces.	Do. do.	False membrane sometimes on the fauces.
Caused by irritation of dentition, disordered bowels, &c.	Caused by exposure to cold, or inhalation of irritating matter. Is often epidemic.	Caused by exposure to cold and damp; less frequently epidemic. Children of some families peculiarly liable to it

If we find, in addition to the preceding signs, that portions of false membrane have also been ejected, the case is demonstrated to be "laryngo-tracheitis with false membrane," this sign being pathognomonic of this form of the disease.

If, then, a child, hitherto in perfect health, wakes in the night with a croupy cough and stridulous breathing, the presumption is that it is mere laryngismus; and this idea is confirmed if the patient be a delicate, irritable child, and has not completed the process of dentition, or is probably suffering from irritation in some portion of the alimentary canal. A simple emetic of ipecac. or wine of antimony, is the most powerful remedy which would be justifiable in such circumstances; and such a remedy will usually at once remove the symptoms.

If the child has had a catarrh for two or three days, however, the danger of laryngo-tracheitis is increased. But if there is no fever, we are not yet justified in considering the case any thing more serious than catarrh. The prevalent medical diathesis of the time will, however, aid much in deciding this point. If there is an epidemic catarrh at the time, the previous presumption will be confirmed, and mild treatment only will be justifiable. On the other hand, if laryngo-tracheitis is common at the time, the patient must be watched with the greatest care, after the simple remedies required by the present condition have been administered. We are, however, also to remember that a dryness of the mucous membrane, in exposure to cold, may produce a sudden hoarseness like that of catarrh.

The probability of incipient laryngo-tracheitis is increased, however, in the circumstances just mentioned, if the patient, or if an older child in the same family, has before had an attack of this disease; while a previous attack of laryngismus, or mere catarrh, with similar symptoms, leads to the opposite presumption. The existence of a false membrane on the pharynx confirms the idea of true laryngo-tracheitis. Hence, the fauces and the pharynx should, in *every case*, be carefully examined.

The stridulous inspiration of laryngo-tracheitis may be very well imitated in mere laryngismus; and in the former disease may often be detected by the aid of the stethoscope, before it can be in any other way.

These are the most prominent points to be observed in enabling us to distinguish laryngo-tracheitis from mere laryngismus and catarrh. It is not deemed necessary here to enumerate the points which distinguish it from erysipelatous and submucous laryngitis, or cedema glottidis, which may result from them.

The question in regard to the sthenic and the asthenic varieties of laryngo-tracheitis, must be decided by the character of the symptoms, and the condition of the child at the time of the attack. The presumption may be that the disease will assume the first form in a robust, plethoric child,

and the second form in opposite circumstances. Regard must also, however, always be had to the medical diathesis of the time; the strongest children not unfrequently having the asthenic form of the disease, from certain contemporaneous epidemic influences.

Part II.

The treatment of Infantile Laryngo-Tracheitis, or Croup, as rationally based on the preceding views of its pathology.

The *indications* in the treatment of infantile laryngo-tracheitis, or croup, are at once suggested by the following recapitulation of the prominent points of the preceding part of this paper.

1st. Croup is always a laryngo-tracheitis, or inflammation, not of a specific kind, of the mucous membrane of the larynx, extending thence into the trachea, also, at least.

2nd. Like other inflammations, it may be either sthenic or asthenic.

3rd. Its progress is always downwards in the air-passages, whether it commences in the larynx, or (as is more frequently the case) higher up.

4th. It is always attended by an exudation of plasma upon the surface of the inflamed membrane.

5th. The inflammation subsides in the part on the occurrence of exudation.

6th. If the plasma *remains* on the surface (it being usually detached and removed in case of the adult, by coughing), it may

a. Become re-absorbed, which is a rare result; or,

b. Be converted into purulent matter, and then excreted; or,

c. Become organized into a false membrane. This last result is far more common in early life than in adults, though then occurring only in about one-sixth of all the cases. Consequently it can never be predicted, at the commencement of the disease, whether a false membrane will, or will not, be formed.

7th. If a false membrane is formed, it will become spontaneously detached, if the patient's life is sufficiently prolonged. Its removal, however, in whatever way effected, does not *insure* recovery.

8th. Laryngismus is associated, to some extent, with true laryngo-tracheitis, as a matter of course.

9th. Catarrh generally precedes infantile laryngo-tracheitis. But the catarrhal discharge, *so-called*, during the more advanced periods of this disease, is the purulent fluid formed by the degeneration of the exuded plasma.

10th. Diphtherite, or the "croup of adults," differs not *pathologically*

from infantile laryngo-tracheitis. Generally, however, it is an asthenic form of laryngo-tracheitis, since it usually attacks persons already debilitated by other diseases.

The *indications* in the treatment of infantile laryngo-tracheitis, which flow from this view of its pathology, are as follows :

- I. To arrest the inflammatory process, and control the laryngismus.
- II. To prevent the organization of the exudation into a false membrane.
- III. To remove the false membrane, if formed.
- IV. To support the patient's strength, so far as may be, through the disease.

I. *Means for averting the inflammatory process.*

We here include :—

- a. Blood-letting.
- b. Tartrate of antimony, nitrate of potassa, mercurials (?).*
- c. Emetics (?).
- d. Expectorants (?).
- e. Counter-irritants (?).
- f. External application of cold.
- g. Applications internally to seat of inflammation.

a. *Abstraction of blood.* In a clear case of sthenic laryngo-tracheitis, two or three leeches, according to the patient's age, may be applied to the throat or the top of the sternum, and the bleeding be promoted by a cataplasm; but it must be remembered that 3 oz. of blood lost by a child six months old, is more, proportionately, than 1½ lb. lost by an adult, and that children generally manifest but a slight tolerance of blood-letting. Moreover, it must be remembered that this remedy is applicable only for the sake of arresting or removing the inflammation, and is therefore entirely out of place after the exudation is poured out, and the progress of the inflammation is thus arrested. The only fact in favor of its adoption after this has occurred, is, that as the inflammation progresses *downwards*, it may still be advancing below the point covered with the exudation. This will be indicated by the

* The remedies marked (?) are of doubtful value for fulfilling this indication.

state of the pulse, and of the respiration, and by other concurrent signs. But the presumption always is, that blood is *not* to be taken in the absence of decided reasons to the contrary.

Venesection, we believe, to be very seldom proper in a patient less than 7 years old; and blood should not be taken, in any way, in asthenic cases.

b. Tartrate of Antimony. It is a fact never to be overlooked in the treatment of inflammation, that the tartrate of antimony may be so administered as to become a most valuable substitute for blood-letting. I allude to its powerful effects as a *sedative*, when administered in small and frequently repeated doses, *e. g.*, one-thirtieth to one-twentieth of a grain dissolved in water, administered every hour or two, to an infant of twelve months, until the pulse becomes softer and slower, and the surface cooler, when the frequency of the doses is, of course, diminished, so as merely to continue this effect. In this way the reducing effects of loss of blood are produced temporarily, and till the inflammation is arrested; with the advantage over blood-letting, that on withdrawing the remedy, at any time when desired, the circulation rises again, and all permanent debility is prevented.

The effects of this remedy are, however, to be watched with the utmost care. Some infants easily yield to its sedative effects, and in some, violent irritation of the alimentary canal is produced by it. An infant, six months old, has been destroyed by one-thirtieth of a grain of this remedy; and another barely escaped with life, after taking, in three doses, sixty drops of the hive syrup. If given to the amount to produce vomiting, its sedative effect, as is well understood, is not experienced. It is better tolerated in combination with very small doses of an opiate.

Nitrate of Potash.—This remedy should hardly be relied on as a sedative in infantile laryngo-tracheitis, unless in asthenic cases, and also when from a peculiar irritability of the alimentary canal, or some other cause, the tartar emetic is not well borne. In such cases it may be given freely in solution, with some probable effects in averting the inflammatory process. The entire inappropriateness, however, of this remedy, and still more of blood-letting and antimony, *after* the exudation has occurred, and the pulse has fallen, will be apparent to all. (p. 11.) *note*

Mercurials, especially Calomel.—This will be considered under the next indication, as we believe it has very little, if any, power to *arrest* inflammation of the air-passages. A single dose of two to five grains may be given as a cathartic at the outset, if for any particular reason it is indicated, as a stimulant to the liver; and from both its safety and certainty of operation in children, it is generally judicious to administer it as above if any cathartic is required.

c. Emetics.—Much stress has been put upon the action of emetics in infantile laryngo-tracheitis; and all, as we believe, upon a false theory of their action. This particular point, however, will be considered under the second indication.

Inasmuch as laryngismus is often produced by irritating matter in the stomach, and when present in this disease, is doubtless increased by these causes, a mild emetic is never injurious, and is often very beneficial at its commencement. Indeed, in some cases of catarrh, very difficult at first to distinguish from this disease, an emetic will at once completely relieve the patient, and remove all anxiety as to the nature of the case.

Moreover, when given in the first stage of actual laryngo-tracheitis, an emetic may produce such a shock to the system as to put an end at once to the disease, by its mere "perturbating" effects. After the disease is fairly established, however, emetics, frequently repeated, are entirely out of place, as will be shown further on. While an emetic operation promises such an effect, or if the contents of the stomach are such as require to be removed, an emetic of ipecac. and tartrate of antimony, or, in asthenic cases, ipecac. and sulphate of zinc, may be used; it being understood that the emetic operation is not to be repeated unless positive indications subsequently arise.

When called to a doubtful case (like those of the second preceding paragraph*), we have generally given ʒ ss. to ʒ j. of the syrup, Scillæ Comp. (Hive Syrup), every fifteen minutes till free emesis is produced.

d. Expectorants are useful rather to fulfill the second and third indications, than for the arrest of inflammation. The tartrate of antimony, if given as already recommended, at the same time proves an efficient expectorant.

We shall specify certain expectorants, in the proper connexion, merely adding here, that they must not be given in the early stage, to the exclusion of the remedies which arrest the inflammatory process.

e. Counter-irritants are, moreover, not of any decided benefit, we believe, in the first stage of the disease; and they also interfere with the external local applications for the removal of inflammation, next to be mentioned.

After the heat of surface and the excitement of the circulation have somewhat subsided, and the application of cold is no longer beneficial, blisters and stimulating liniments may prove very beneficial in promoting the absorption of the exuded plasma; and they will, therefore, be again alluded to in another connection.

* See also p. 14, second paragraph.

f. Cold applied externally.—We consider this of the greatest value and importance. If cold applications are efficacious in all cases of external inflammation, they are scarcely less so here, where the inflamed surface is so nearly superficial. Cold must, however, be continuously applied, to produce the desired effect. Applied at intervals, indeed, it rather promotes than retards the inflammatory process; since, during the intervals, the temperature rises above the normal standard, in consequence of the reaction of the chill on the surface.

Cold water may be constantly dropped from a sponge upon a compress laid over the throat of the child; and the latter should be of only one or two thicknesses of linen, that evaporation may go on as rapidly as possible.

The application of hot water, early in the disease, as sometimes recommended, therefore appears to us objectionable; and that of rapid vesicants (*aqua ammoniæ*, &c.) still more unwarrantable.

g. Internal application to the seat of the inflammation.—First to be mentioned under this head is the solution of lunar caustic, applied by means of a syringe, or sponge-probang,* as recommended by Dr. Horace Green. We have used both instruments, and decidedly prefer the latter, as applicable in *all* cases of disease in which the solution is required, while the former is not so, in our judgment, though it answers well in many instances.

The solution most frequently used is that of 40 grains of the crystals of nit. silver, to 1 oz. of distilled water. This solution has a more sedative and less irritating effect upon the mucous surface than a weaker one, as of 10 or 20 grains to the ounce of water.

In our judgment, there is no local application for arresting the inflammatory process in this disease, to be at all compared with the solution just mentioned. It should be, at first, applied to the fauces and pharynx only; and then, in 15 to 30 minutes, the probang may be passed into the larynx, and through the rima glottidis if required. The operation should be repeated in some cases, three or four times daily, in others only once.† Other solutions, or fluids, thus applied, may also be found useful—such as glycerine, olive oil, &c.; but none will probably be found to possess the efficacy of the nitrate of silver. Applied to the pharynx and fauces, indeed, as soon

* The sponge must not exceed one-third to one-half inch in diameter, to pass through the rima glottidis of a child two years old, one-third inch being rather large at one year.

† Dr. H. Green has established the interesting fact, that much less irritation is produced by this operation in children with *croup*, than in adults with chronic laryngeal disease.

as the false membrane has appeared in these parts, it has frequently arrested the inflammatory process at once, and thus prevented its extension into the larynx and trachea. We should, therefore, feel it an unpardonable omission, at the present day, should we fail early to cauterize the pharynx (and the larynx and trachea, if already invaded by the disease), and to repeat the operation as circumstances might require in every case of laryngo-tracheitis. The objections sometimes raised, that this is a difficult operation, and also, if accomplished, a dangerous one—were always too puerile, and are now too generally known to be entirely unfounded, to require a refutation here.

The only other method of direct local application we shall mention, is by inhalation. The inhalation of aqueous vapor is especially to be commended, on account of its soothing effects upon the inflamed surface; and it is also a valuable remedy for diminishing the laryngismus accompanying true laryngo-tracheitis. Its efficacy in this respect may be also increased by the addition of camphor, or stramonium, and other narcotics.

X *Remedies to diminish the Laryngismus.*

We have just mentioned aqueous vapor, with camphor or stramonium. Tartrate of antimony also diminishes it, while producing its general sedative action; and any appropriate emetic, even, may be given with a view to diminish it, if it appears to be mainly due to irritating matters in the stomach. Opiates, and especially laudanum, have also been recommended. We would advise them only to the extent to overcome any existing nervous irritation, cautiously avoiding any decided narcotic effect upon the respiration, in a disease in which diminished aëration of the blood is the principal cause of a fatal result. For a similar reason inhalations should be continued only for two or three minutes at a time, and frequently repeated, and the apartment kept thoroughly ventilated. We also recommend the hydrocyanic acid as both a valuable sedative and anti-spasmodic.

II. *Remedies to prevent the organization of the exudation into a false membrane.*

The means included under this head are:

1st. Those intended to *remove* the exudation at once,* viz. expectorants, emetics, and the sponge-probang.

2d. Remedies which diminish the *organizability* of the plasma: calomel and alkalies.

3d. Remedies promoting absorption of the exudation: counter-irritants.

a. *Expectorants.*—In adults the exuded plasma is usually removed at

* See p. 8, third.

once, or after degenerating into pus, by the act of coughing and expectoration. In infants this result far more rarely occurs, since they do not expectorate by voluntary efforts. Any remedy, however, which will render more fluid and abundant the secretion upon the air passages, will so far aid in detaching the exuded plasma; and which will then be expelled by the simple act of coughing. Expectorants, therefore, are beneficial to this end, and may be administered to fulfill this indication. We will mention only the syrup and other forms of ipecac. seneca, and the squill. Alkalies become expectorant also, as will be seen under the next indication.

b. Emetics exert no marked effect in removing the plasma from the air passages, and hence are not to be commended. But this topic also will be considered at length, under the next indication.

c. The Sponge-probang. But the most certain method of directly removing the plasma, is the application to the surface, of this instrument. If merely moistened with water, it will very well accomplish this object. But since the solution of nitrate of silver (grs. xl. to $\frac{x}{j}$ j. water) before mentioned, acts on the exudation both to destroy its organizability and to detach it, while it at the same time arrests the inflammatory process, as has been shown, we always employ it. Indeed, we should not hesitate to make an opening into the trachea through which to apply the solution, in some cases, if it were otherwise impossible. But we shall recur to this again (p. 25). 27

2. We next consider the remedies administered to diminish the organizability of the exuded plasma.

a. The preparations of mercury, properly administered, possess the property just mentioned; but since the proto-chloride of mercury (calomel) is the one which manifests this property in the highest degree, and has been much vaunted by some in the treatment of infantile laryngo-tracheitis, we shall speak of it somewhat at length, believing that some remarks upon its precise effects in inflammation will aid in assigning to it its true value in the disease under consideration.

It has long been admitted that calomel is most useful in inflammations of *serous membranes*. *E. g.* in pleurisy, it is believed to promote the re-absorption of the exuded plasma, and thus to prevent the formation of adhesions and false membranes. It has, therefore, also been termed an "absorbefacient," or excitor of the absorbents.

We admit that calomel is most useful in inflammations of serous membranes, or rather in *all* inflammations where false membranes may be formed; also that it favors the absorption of the exuded plasma, and thus may prevent their formation; but, at the same time, it does not in any way increase the action of the absorbent vessels of the part affected; nor does it arrest the inflammatory process itself.

The whole effect of calomel in the diseases just mentioned, may be thus expressed: *it merely diminishes the organizability of the exuded plasma*; so that it is not so rapidly organized, and therefore a longer time is afforded for its re-absorption before organization takes place. This effect may now be regarded as established by experiment.

We are not cognizant of a single fact tending to show that calomel has any direct effect to arrest the inflammatory process itself; and therefore we have not given it any prominence in our list of remedies for that object (p. N). 16

But in cases of inflammation of the alimentary canal (enteritis, colitis, &c.), calomel may exert a very decided *indirect* effect to arrest the inflammatory process itself. All the blood in the minute vessels of the mucous membrane of the alimentary canal, being collected by the vena portæ, and transmitted through the liver, any remedy which excites the action of the liver (i. e. acts as a *cholagogue*), promotes the circulation through the vena portæ, and they relieve congestion of the membrane itself. Thus calomel indirectly acts in enteritis and colitis to arrest the inflammatory process itself; while at the same time the flow of the bile, thus produced over the inflamed surface, also produces a positive soothing effect.

But it is only when calomel acts as a *cholagogue*, and therefore to some extent as a *cathartic*, that it arrests the inflammatory process even in the diseases just mentioned. To produce this effect it must be given also in doses (to an adult) of 5 to 15 grains. In laryngo-tracheitis, on the other hand, it has no such effect, in any dose, to arrest the inflammation; and so far, therefore, and in such doses, it is not indicated in this disease, except perhaps, in a single dose at the outset, as before explained (p. 17). 16

On the other hand, calomel administered in doses, frequently repeated, of $\frac{1}{2}$ grain to 2 grains (to adults), produces no cholagogue effect, but an entirely different one, from its gradual absorption, probably, into the blood, viz. a diminished power of organization in the blood plasma, as before stated. Whether this effect is produced by diminishing the fibrine, and therefore *weakening* (and thinning) the plasma, is not yet conclusively decided; though we regard this as the true explanation. Hence the value of calomel in small doses in all inflammations in which false membranes and adhesions are liable to occur, as pleurisy, endo-carditis, and the disease now under consideration.

While, therefore, we unqualifiedly condemn the custom of some, of giving large doses of this remedy (10 to even 20 grains) every three or four hours, in infantile laryngo-tracheitis, we may also perceive that small doses regularly repeated may prove of the utmost benefit. But we are to arrest the inflammation first, by the means before recommended, or at least employ them for a time, before we resort to this remedy.

After the first twenty-four or forty-eight hours, therefore, according to circumstances, it is desirable in a sthenic case, to commence with doses of calomel of $\frac{1}{4}$ to $\frac{3}{4}$ grain (for a child 9 to 12 months old), every four hours, or oftener; diminishing the quantity if any marked cholagogue effect is produced. This last effect is less liable to occur if $\frac{1}{4}$ to $\frac{1}{2}$ grain of the pulvis ipecacuanhæ comp. (Dover's powder) is added to each dose.

Yet calomel must be administered in this disease, even in the small doses just recommended, with great caution, and constant reference to the delicacy of the little patient. True, there is very little danger of pytalism occurring before the age of five to seven years; and it has been pronounced impossible before the first dentition commences. But it is now pretty generally known that mercurial preparations (and especially calomel) are not well borne by scrofulous—and we will also add anæmic—subjects, whatever their ages or diseases. It produces great general debility; and if any accident exists requiring the aid of the reparative process, as an ulcer or a wound, it may indefinitely prevent this process from occurring, or even lead to phagadæna, or perhaps sloughing, in the part instead. The plasma always possessing a low grade of vitality (organizability) in such persons, becomes so far debilitated by the mercurial that reparation is impossible; and it is only on discontinuing it, and substituting tonics and proper diet, that the desired result ensues.

The fact just mentioned is here introduced for the sake of application in this connection, as well as for illustration. In scrofulous children the danger of organization of the plasma into a false membrane in true laryngo-tracheitis, is far less than in robust children, on account of its low vitality there; nor do they tolerate the calomel if given as just explained. To such children, therefore, it is better to give the pil. hydrargyri (if any mercurial), and to withhold calomel entirely. In every case of *asthenic* laryngo-tracheitis, the propriety of administering calomel must be thoroughly canvassed before it is decided to administer it. As a general principle, certainly, it should be administered only in the *sthenic* form of the disease.

Though we have so far prolonged our remarks upon calomel, we must also record our testimony in favor of one more preparation of mercury in this disease: the subsulphate, or Turpeth mineral.* It is a valuable substitute for calomel in less sthenic cases, in doses of $\frac{1}{4}$ to $\frac{3}{4}$ of a grain; and is to some extent an expectorant also.

b. Alkalies. It has been established by experiment that alkalies also, like calomel, diminish the organizability of the blood plasma. They are, however, much less efficient in this way; and for that very reason are appropriate in the *asthenic* form of the disease.

* The attention of the profession was first called to its use in this disease, we believe, by Dr. Hubbard, of Hallowell, Me.

Hence they become a very valuable substitute for mercurials, to prevent the organization of the exuded plasma, and should always be preferred when a milder remedy is believed to be sufficient. We have had more experience of the effects of the bicarbonate of soda in this disease; giving it in the dose of 3 to 5 grains every 4 hours, to a child one year old. Alkalies are well known to render less tenacious the viscid sputa of pneumonitis and acute bronchitis, and hence become valuable aids to expectoration in these diseases. Their power of rendering more fluid the fibrine mixed with the mucus in such sputa, accounts for this effect, and renders them also valuable as expectorants (see p. 10), as well as in preventing organization of the exuded plasma, in infantile laryngo-tracheitis.

As *alkaline stimulants*, the bicarbonate and the hydrochlorate of ammonia, are also valuable in the advanced stage of the disease, for sustaining the patient's strength, and promoting expectoration.

3. *Counter-irritants* may, lastly, be mentioned, as promoting absorption of the exudation, and thus preventing its organization. But, in regard to these, we merely refer back to page 18.

III. *Means for removing the false membrane when formed.*

These are *direct*, the probang; or *indirect*, as expectorants, counter-irritation, emetics, and tracheotomy.

a. The only direct method of removing the false membrane which need be mentioned, is the application of the solution of the nitrate of silver as already explained. We need not insist on the value of this application for the direct removal of the false membrane, at the present day, since cases have been recorded, in most of the principal medical journals, within the last two years, in which portions of the false membrane have been at once thus removed, and the patient evidently saved.* The sponge is to be carried into the trachea, and the operation repeated once in 2 to 24 hours according to the urgency of the case. With our appreciation of the value of this operation, we could not conscientiously omit it in the fulfillment of the indication now under consideration.

Expectorants and *counter-irritants* may still be continued, as under the preceding indication.

b. *The use of emetics for removing the false membrane.* Since emetics frequently repeated, have almost uniformly been recommended for the purpose just mentioned, and much injury, in our opinion, results from this

* For cases, see Dr. Chapman's articles in the March and July Nos. of the New York Journal of Medicine, and Dr. Green's paper in the July No. of the Monthly.

practice, we shall attempt to show that it is founded on a false hypothesis, and is objectionable in all respects.

The foundation of the idea that the act of vomiting will expel a false membrane from the larynx or trachea, is the assumption that the acts of vomiting and of expiration from the lungs (including also coughing and expectoration) are, in their mechanism, almost identical. An account of the mechanism of both these actions will, however, demonstrate their entire dissimilarity, so far as their effects are concerned, and that an emetic cannot possibly exert any direct effect in the expulsion of a false membrane from the air passages.

Everybody knows that the object of the act of vomiting is the ejection upwards through the œsophagus into the buccal cavity, of the contents of the stomach; while that of coughing or expectoration (or forced expiration) is to expel into the same cavity, through the rima glottidis, the contents of the air passage below. If, therefore, mere emesis will produce the latter effect, we should expect that coughing, or expectoration, would evacuate the stomach, and that, therefore, we might administer an emetic or an expectorant, indifferently, to expel the false membrane. Admitting this, however, the remedy is not needed till the membrane is formed; and this occurs in only about one-sixth of all the cases. The indiscriminate use of *emetics* is, therefore, unjustifiable at all events and on any supposition. But we proceed to show that an emetic operation cannot possibly expel a false membrane from the air passages, on physiological grounds, except so far as it may do so by causing a violent concussion of all the contents of the thorax, or by some irregular and violent motions of the trachea—all of which indirect effects being also easily secured, as will appear, by far milder means.

The following account of the mechanism of the two actions in question, vomiting and forced expectoration, will explain the preceding remarks:

1. In *vomiting*, a full inspiration first occurs, which, ~~disturbing~~ *disturbing* the thorax, puts all the smaller expiratory muscles on the stretch, while the abdominal muscles are in a passive state, and the diaphragm is depressed and strongly contracted. Next, the rima glottidis is closed, and all the inspired air being thus retained in the air passages, all the muscles just mentioned are *fixed* in the positions indicated. Thirdly, a sudden contraction of the abdominal muscles occurs; and the stomach, being thus compressed between them and the previously depressed and fixed diaphragm, its contents are forced up through the œsophagus and pharynx, and the act of emesis is completed. Does the stomach also contract in aid of the abdominal muscles? It is very nearly, and generally *entirely*, passive in emesis. At least, vomiting has been made to occur, experimentally, in the lower ani-

mals, when a bladder, containing liquid and solid matter, was substituted in place of the stomach, after the latter had been removed.

Here, it will be seen, ejection of any substance from the air passages is impossible, since the glottis is completely closed, and the diaphragm continues depressed, and the thoracic muscles fixed—and of course the lungs cannot be *compressed*—till the first act of emesis is completed. Then follows another deep inspiration, and a second act of vomiting succeeds, as before explained.

2. In *coughing* or *expectoration*, a full inspiration also first occurs, as in the case of vomiting, and the expiratory muscles of the thorax, and the diaphragm become fixed, as in that case already explained. Secondly, the rima glottidis is suddenly opened, and the abdominal muscles instantly contract upon the stomach as before. But the diaphragm immediately relaxing, the stomach carries that muscle upwards against the base of the lungs; which being thus suddenly compressed, the contained air is violently forced up through the trachea and larynx, and thus any solid or fluid substances are expelled through the glottis into the buccal cavity, and the act of expectoration, or coughing, is completed.

Thus the first or preparatory movement to the acts both of vomiting and coughing, the full inspiration, is precisely the same; while the acts themselves have nothing in common, except the contraction of the abdominal muscles.

We have seen that the act of vomiting cannot possibly expel matters from the air passages, because the glottis is closed. A less perfect closure of the cardiac orifice of the stomach occurs, however, during the act of coughing; and, therefore, it sometimes happens that a violent paroxysm of coughing produces a partial evacuation of the stomach (or an act of emesis), at the same time. This is, indeed, very common in whooping-cough, and not very infrequent in phthisis; though frequently in the latter disease, the act of vomiting instantly *succeeds* that of coughing, being produced by the contact of the expectorated matter with the velum or pharynx, which are in a state of high irritation. Some irregular contractions of the diaphragm may also probably occur in this case, and the stomach thus become somewhat compressed in the act of coughing; while, normally, it is scarcely so at all. Vomiting not seldom accompanies the cough produced by the introduction of the caustic solutions upon the sponge-probng into the larynx and trachea, since thus a temporary spasmodic closure of the glottis is produced. We of course, distinguish between these cases and those where the caustic is applied only to the fauces or some part of the pharynx; the vomiting being directly due, in these instances, to the irritation of these parts.

But we will not pursue the subject farther. It is sufficient to have

shown that the act of vomiting does not, and cannot, directly, expel any substance from the air passage, through the glottis into the buccal cavity.

But if a quantity of solid contents be forced from the stomach through the œsophagus, must not the mass, from the anatomical relations of the canals, act on the trachea and its contents, while on its way through the other tube? Doubtless, it may produce motion of this tube to some extent—the latter being somewhat proportional to the amount and solidity of the matters ejected, and the force employed to eject them. But if any thing is to be gained in this violent and indirect manner, the same results may be secured by exciting attempts at vomiting (or retching) by titillation of the uvula, or the application of the sponge probang (with or without the caustic solution) low in the pharynx. In this way we might, at least, allow the patient to escape from the mischievous irritating and debilitating effects of the emetic upon the stomach itself; and which are all the more certain to ensue from the well-known difficulty in producing an emetic operation when infantile laryngo-tracheitis is somewhat advanced, and the consequent certainty, almost, that large doses, or violent remedies,* or both, will be administered.

Our reasons will, however, now be apparent for our decided condemnation of emetics frequently repeated in this disease, with a view to remove the false membrane. We consider an emetic proper only at the commencement of the attack, as already explained, and at such other times during the progress of the disease as they may be required, simply to evacuate the stomach,† and believe the practice we are condemning has destroyed many a patient who might have recovered in the absence of such prostrating and perturbing treatment.

Tracheotomy, as subservient to the removal of the false membrane.—Tracheotomy is regarded by those only who remember that death almost always soon follows it, when performed in infantile laryngo-tracheitis, as a most formidable operation. The surgeon, however, of experience, does not apprehend any great risk to his patient from this operation, if performed under ordinarily favorable circumstances; and he very seldom finds a fatal result essentially hastened by it. The truth is, that the operation is usually performed as a *last resort*, when the patient is so nearly moribund that no human agency can prolong life more than a few hours or minutes even—or when the most trifling operation might hasten the fatal issue. If we are ever to form a just appreciation of the value of this operation in the disease under consideration, we must perform it *seasonably*, while the patient still

* Sulphate of zinc and of copper are very generally recommended.

† A tea spoon full of alum, dissolved in four ounces of water, is a very certain emetic for a child two years old, provided the stomach needs to be evacuated in the advanced stage of this disease.

has strength to survive the operation, and also to respond to the new circumstances in which it places him. If the operation for hernia were always delayed till gangrene has ensued, it would be generally decried, and with just as good a reason, we submit, as tracheotomy now is.

We do not mean to say that tracheotomy should be performed, and seasonably, in every case of this disease, as the other operation should be in every case of irreducible strangulated hernia. But we mean to insist that tracheotomy shall be performed *seasonably, if at all*, and that thus alone can we ascertain its true value. We mean also to express our conviction that, thus performed, tracheotomy will be found a most valuable part of the treatment of infantile laryngo-tracheitis in many cases in which a false membrane has formed.*

We have implied that tracheotomy is not in itself a formidable operation; and yet, if a more safe and simple procedure than the one usually resorted to can be substituted, it were very desirable. Dr. Marshall Hall has a very simple method. But for the purposes now about to be considered we should prefer the operation recommended by Dr. Batchelder of New York.† He, indeed, proposes to substitute laryngotomy for tracheotomy, but extends his incision downwards through the cricoid cartilage, and also the first ring of the trachea, if required; thus rendering the operation, when required, a *laryngo-tracheotomy*. This operation he has himself seasonably performed some fifteen or twenty times, and has always found it to answer "perfectly well" the purpose for which the opening was made.

We conceive that the operation in question must have in view one or more of the following objects:

1. To prevent immediately fatal consequences from asphyxia, induced by laryngismus.
2. To afford an opening into the trachea, for the admission of air, larger than the rima glottidis, which is now partially filled by the false membrane.
3. To afford an opening through which applications may be made directly to the larynx, trachea, and even to the bronchial tubes.
4. That the false membrane may be removed through the opening made.

The second and fourth objects only, imply that a false membrane is formed.

1. If we are present during a paroxysm of laryngismus, which we judge must prove fatal, of course the operation is to be performed without delay.

2. A recurrence to the pathology of this disease (p. 11, 1 and 2) will show how little probability there is, after the first two or three days,

* Trousseau, who has probably operated more times, and with greater success, than any other person, operates earlier than is common with others.

† New York Journal of Medicine, January, 1854.

that the false membrane does not already extend into the trachea, at least, if not into the bronchi. If we operate with this end alone in view, therefore, we shall very probably be disappointed.

3. But we may make an opening for the sake of making applications through it to the larynx, trachea, and bronchial tubes; and here an entirely new field opens to us. And we hope not to startle those overmuch who shudder at the idea both of the operation, and of the probang now so frequently mentioned, if we say that in our opinion cases may occur in which it is justifiable to make an opening into the trachea for the mere purpose of applying the caustic solution and other remedies directly to the seat of the disease, and to the extent required.*

If, for instance, the case be a sthenic one, while from spasm or swelling of the larynx, or some other cause, it is found impossible to pass the caustic solution through the rima glottidis, though it is very certain that a false membrane will be or has formed, and all of several children of the same family, attacked by the disease, have died of it; in this combination of circumstances, certainly we should feel justified in performing the operation for the object now under consideration.

4. Finally, we may operate in order to remove the false membrane through the opening, though the caustic may have been applied through the natural passages. For we may certainly act to greater advantage after the operation, if we have failed to remove the membrane before it. And now, as in the last case, we shall feel the necessity of applying the caustic solution, in order to *bring* away the membrane, and not wait for it to be discharged through the opening spontaneously.

These we conceive to be the legitimate objects of tracheotomy, when performed in infantile laryngo-tracheitis; and if restricted to the cases in which it is actually required, and seasonably performed, we believe it will prove a powerful means of diminishing the mortality from this disease. We must add, however, that the number of cases otherwise actually requiring it is greatly diminished by the internal application, through the natural passages, which has been so often recommended; and that but few cases in which this can be effectually made, will require the use of the scalpel.

IV. *Means for sustaining the patient's strength.*

If it be recollected that the false membrane formed in infantile laryngo-tracheitis is uniformly detached spontaneously, if the patient's life is sufficiently prolonged (p. 12, 3d), it will seem to be a matter of great importance to sustain the patient's strength, so far as possible, not only by the avoidance of all unnecessary medication, but also by direct means, so

* See page 21.

far as circumstances will allow. This inference has by no means been sufficiently recognized; as both the heroic treatment and the withdrawal of nourishing aliment, so generally adopted, abundantly prove.

We hardly need do more under this head, however, than to call attention to this subject, to make its importance apparent, and to induce the adoption of the means best calculated to secure the object in each particular case. In *asthenic* cases, it is a matter of the utmost importance to continue the use of broths, milk-porridge, wine whey, weak milk-punch, and the like, throughout the disease; to which tonics and stimulants are also to be added as the strength declines. In the treatment of *sthenic* cases, also, it must not be forgotten that infants are very soon prostrated by inanition, as well as by blood-letting and powerful emetics; and while we avoid the latter, we must also see to it that nutriment enough is taken.

We now give a tabular view of the treatment we have recommended for the two forms of this disease. Diphtherite, being regarded as an *asthenic laryngo-tracheitis* (p. 16, 10th), requires no special attention here.

	<i>Sthenic Laryngo-tracheitis.</i>	<i>Asthenic Laryngo-tracheitis.</i>
I. To arrest the inflammatory process, and control the laryngismus.	An emetic; followed by a full dose of calomel, if required. Leeches to throat, or over the sternum; followed by cold applied continuously. Tartrate of antimony; sedative doses, cautiously administered. Internal application of solution of nitrate of silver. Inhalation of aqueous and narcotic vapors. Opiates, with caution. Hydrocyanic acid, do. do.	Do. do.; or pil. hydrargyri, instead of calomel. Leeches doubtful. Cold continuously applied. Nitrate of potassa.
II. To prevent organization of the exuded plasma.	Sponge-probang and caustic solution. Expectorants. Calomel, in small doses. Alkalies. Counter-irritation. Tracheotomy?	Do. do. Stimulating expectorants. Turpeth mineral. Do. Do.
III. For removing the false membrane when formed.	Continue caustic solution. do expectorants. do counter-irritation. do alkalies. No emetics, or calomel. Tracheotomy, <i>seasonably</i> , if at all.	Do. do. Do. Do. Stimulant alkalies. Do. do. Do. do.
IV. To sustain the strength.	Milk-porridge, arrow-root, broth, &c. Tonics, if required.	Do. do.; also wine whey, milk punch, &c. Tonics and stimulants.

Thus we have given expression to our views of the pathology of infantile laryngo-tracheitis, or croup, and of the treatment rationally based upon those views. If, in attempting to simplify the pathology of a subject so very differently understood by different writers, we have committed the error in the opposite direction, of including under the same term pathological conditions which are really, for any practical purpose, different, we heartily regret it. But we can hardly doubt that the attempt will be regarded as having been made in the right direction; and we will be happy to acknowledge our error, when it is shown that our views are inconsistent with the present state of pathological science.

In respect to *treatment*, we have not sought to add new modes—believing the list of remedies already too ample—but rather to appreciate the precise value of the remedies sanctioned by long experience, and above all, to inculcate that caution in the use of them all, which the tender age and the delicacy of the patient demand, and which has too generally been almost entirely forgotten, we think, in the treatment of this disease.

In conclusion, we may add, that the adoption, in practice, for several years, of the principles proposed in the preceding pages, has confirmed their correctness in our estimation; and we might have given cases of our own in illustration, were it not that we should thus have extended this paper beyond the limits we had proposed, and at the same time, perhaps, have somewhat interfered with its logical construction.

Dartmouth College, Aug. 1, 1854.

