

MANCHESTER

ROYAL

INFIRMARY

Part First.

ORIGINAL COMMUNICATIONS.

ARTICLE I.—*On the Pathology of the Bronchio-Pulmonary Mucous Membrane.* By C. BLACK, M.D., Chesterfield, Bachelor of Medicine, and formerly Medical Scholar in Physiology and Comparative Anatomy in the University of London; Fellow of the Royal College of Surgeons of England, etc. etc.—(Continued from page 11.)

I HAVE now taken a view of the structure and composition of the different tissues which enter into the formation of the bronchio-pulmonary membrane; of the purposes which these various tissues serve, in reference to each other and to the membrane which they form; of the use of the latter, with respect to the important function of respiration; of the structure, form, and chemical composition of the bronchio-pulmonary secretion; and of the particular action of certain re-agents in connection with the subjects under examination.

I have next to consider those deflections from health, in the bronchio-pulmonary membrane, which are continually occurring, and which so frequently compromise life. The diseases and lesions to which this membrane is liable may be arranged under—

1. Inflammatory diseases.
2. Diseases for the most part non-inflammatory.
3. Lesions of structure.

Inflammation of the bronchio-pulmonary membrane may be

1. Simple, acute, or chronic.
2. Sthenic or asthenic.
3. Specific.

Acute Inflammation of Bronchio-Pulmonary Membrane.

This form of disease admits of subdivision into—

1. Simple acute epithelial bronchitis.
2. Bronchitis involving the submucous tissue.
3. Cellulitis, or inflammation of the epithelium of the pulmonary cells.

It is not my intention to detail at length the history of individual symptoms of the particular diseases to which the bronchio-pulmonary membrane is liable, but to notice them only so far as they appear to depend immediately on the pathological condition of the membrane, and to indicate that condition. By adopting this method, I hope to divest these papers of matter which, in the detailed history of all diseases, is more or less superfluous; to trace, step by step, the pathological condition of the membrane and its secretion, and thence to infer the proper method of treatment.

First Pathological Condition of Epithelial Bronchitis.

Now, in simple acute epithelial bronchitis, the first pathological change which takes place in the bronchial membrane, is that of inordinate congestion of its blood-vessels. This increased bulk of the vascular system must occupy increased space; and, as the pressure will necessarily be in the direction in which there is the least resistance, the caliber of the air-tubes is encroached upon, and thus a degree of narrowing occurs. Hence arises the sensation of a tightening of the breathing, and of oppression in the chest, referable in general to the sternum and to a space on each side of it. As another consequence of this increased bulk of the vascular system of the membrane, there is pressure on the accompanying nerves, which thus become irritated, and, by reflex action, induce cough. The cough, however, is at this stage of the disease dry, which is owing to a temporary suspension of the supply of the nutritive blastema furnished by the blood-vessels, the vital tonicity of which is excited to the utmost by their distension. This vital tonicity of the capillaries, acting in opposition to the pressure of the blood urged onward by the heart's action, approximates, within the nearest possible distance, the molecules of which their walls are composed; whilst the outward pressure of their blood has a tendency to flatten and to expand such molecules, so that the two causes, acting at the same time, yet in a direction opposite to each other, obliterate for a while the intervening molecular spaces of the capillary walls, and thus prevent the transudation of fluid. In a short time the continued pressure of the blood overcomes the vital tonicity of the capillary walls, the molecules of which are, as it were, pushed apart, and even to a greater degree than in the healthy condition of the vessels, the intervening molecular spaces are restored and enlarged, and exudation is thus poured out more quickly than in the healthy nutrition of the part. But before this state of matters occurs, the absence of all exudation produces a dryness of the epithelial surface of the bronchio-pulmonary membrane, which suffers in proportion to the length of time it is deprived of its nutritive blastema, and which gives evidence of the amount of injury it has sustained so soon as exudation actually takes place.

Inspection of the membrane, at this stage of the disease, detects

increased coloration, which varies from a bright pink to a deep scarlet, the depth of colour being in proportion to the quantity of blood contained in the part.

It may justly be asked, whether this turgidity of the bronchial membrane can produce any alteration in the natural percussive signs of the chest.

Experience determines in the negative; and the explanation is, that the air, notwithstanding the narrowing of the bronchi, is still admitted into the remote pulmonary cells in sufficient quantity to distend them, and to maintain the healthy resonance of the chest. But were our powers of distinguishing between the finest differences of sound more acute than they are, we should, in accordance with the general law which regulates the production and transmission of sound, at least detect some slight increase of dulness over the site of the affected bronchi. This indeed is even now done where the extent of surface affected is great in one or both lungs, or where inflammation attacks the capillary bronchi. In the latter case the tubes are so narrowed by the congested state of their lining membrane, and by the contraction of their circular fibres, that air is not admitted into the corresponding pulmonary cells in sufficient quantity to distend them; in consequence of which there is a partial collapse of their walls, and thus the natural sound on percussion is deadened. This fact may be verified by attention more particularly to the bronchitic attacks of children, in whom a very palpable deadening of the percussion-note occurs over the back part of the lower lobes of the lungs, as a consequence of partial collapse of the pulmonary cells in inflammation of the capillary bronchi in connection with them. Here I may remark, that children are particularly prone to capillary bronchitis in the lower lobes of the lungs; and that the complete, or even partial, collapse of the pulmonary tissue beyond, to which such inflammation may lead, is not unfrequently confounded with pneumonic consolidation. But to this I shall again return, when treating of the pathology of the next variety of bronchitis, on which the lesion in question more particularly depends.

Although, in simple acute epithelial bronchitis, there is no appreciable difference between the percussion-note and that of health, there is a manifest modification of the natural auscultatory signs. The pathological condition of the membrane already described, and the consequent diminution in the diameter of the affected bronchi, cause the inspiratory and expiratory air to be thrown into sonorous vibrations, and hence the production of certain rhonchi.

The smaller the opening through which the air has to pass, the sharper the edges of this opening, provided they are sufficiently tense and rigid, and the more rapid the moving column of air, the louder and shriller is the note produced.

In the application of these conditions to the present pathological state of the bronchial membrane, we find that they are observed at the points or angles of division of the bronchi; for here the mucous

membrane forms a prominent fold, which narrows the diameter of the corresponding tube, and offers resistance to the inward and outward currents of air. To these points, therefore, and to the smallest bronchi, are to be referred the sibilant rhonchi which attend this pathological stage; whilst to the larger tubes, and particularly to the angles of division of such bronchi, the deeper, rougher, and more sonorous rhonchi are to be ascribed.

Such, then, are the phenomena which immediately proceed from the pathological state of the bronchial membrane during the first stage of inflammation. The more general symptoms are those which indicate more or less excitement of the system, but of which I do not here take any special note.

Before proceeding further, it will be proper to glance at the curative indications which the pathological condition of the membrane at this stage affords.

It has been shown that the membrane is congested, dry at its epithelial surface, and that the vital tonicity of its blood-vessels is excited by the unusual distension to which they are subject. The rational indication of treatment, therefore, is comprised in an endeavour—

1. To unload the overburdened capillaries.
2. To prevent their subsequent distension.

These objects may be attained, by reducing the volume of blood in the system, by soliciting its free distribution through the skin, and by acting directly on the affected membrane. The volume of blood is reduced by general depletion (which, in this variety of bronchitis, is scarcely ever necessary), by purgation, and by increasing the secretions generally. The circulation through the skin is augmented by warm clothing, whilst the tonicity of the capillary walls is excited and maintained by the constant breathing of *cold* air. These means, judiciously adopted and continued, will seldom fail to restore the healthy condition of the membrane in from twelve to twenty-four hours. But, to be successful, no intermission of the remedies must take place; nevertheless, it is not necessary, for the perfect success of the case, that there should be continued purgation for twenty-four hours. One brisk purgative, which shall produce four or five liquid evacuations, will in general be sufficient, in conjunction with an uninterrupted maintenance of a vigorous circulation through the skin and the constant breathing of *cold* air. No contra-indications to the use of these remedies can arise; because epithelial bronchitis never occurs in an asthenic form; but, on the contrary, it is invariably associated with sufficient constitutional power to bear well the effects of the above means. The beneficial effect of *cold* air may be inferred by any one who has paid the least attention to the effects of temperature in the same affection of the nasal membrane, constituting, in ordinary language, a “common cold.” If a person, whilst experiencing that most unpleasant sensation termed a “stuffing of the nostrils,” expose himself, warmly clad, to a cold, dry air, the sen-

sation will, in a few minutes, subside, and he will be able to breathe with perfect ease and comfort; but if he return *immediately* to a warm room, the "stuffing," with all its unpleasantness, very quickly returns. Now, the explanation of these effects of temperature is, that the cold air, by exciting the vital tonicity of the nasal capillary vessels, causes them to contract, to overcome the inordinate pressure of the blood within them, and thus to restore their proper diameter, with which condition all sensation of "stuffing" at once disappears; and that a return to a warm air destroys, in a great measure, this tonicity, relaxes the capillary vessels, and thus favours the re-admission of blood in unusual quantity, whence the immediate return of all the morbid sensations.

Second Pathological Condition of Epithelial Bronchitis.

After the first or congestive stage of epithelial bronchitis has existed for some time, the vital tonicity of the capillary vessels is overcome, and their engorged condition is relieved by the escape, through the intervening molecular spaces of their walls, of an exudation consisting of the watery part of the blood, holding in solution fibrine, albumen, and various inorganic salts. The exudation is, in this particular variety of bronchitis, only slightly in excess of the natural demand. We find, therefore, that the little excess is readily exhausted by the basement membrane and epithelium, which have till now been deprived of their natural supply, and which again observe an activity commensurate with the quantity of nutritive elements which they receive. The recurrence of exudation produces certain changes in the pathological condition of the membrane, out of which particular phenomena again arise.

Thus, by exudation, the conditions necessary for epithelial growth are again restored, mucus is eliminated, and the surface of the membrane is covered with an excess of its natural secretion. At the same time, owing to a reduction in the size of the capillary vessels, pressure is removed from the corresponding nervous filaments, and cough is thereby less troublesome than in the previous stage of the disease. It is now chiefly excited by the presence of an excess of mucus in the bronchi, in consequence of which, although pretty frequent, it becomes more paroxysmal. The partial removal of the congestion restores, to a corresponding extent, the normal diameter of the bronchi, and hence an equivalent reduction in the sensation of tightness and oppression of the breathing.

If, however, the secretion of mucus rapidly takes place, or if accumulation occurs, as generally happens during sleep, the oppression of breathing, until the mucus has been expelled, is even greater than in the first stage.

The percussion-note of the chest still remains as clear as in the previous stage; but, with the pathological change which has taken place in the membrane, there is a particular modification of the

auscultatory signs, indicative of its occurrence. Thus, secretion having taken place into the bronchi, the air, on entering and emerging from the lungs, must necessarily pass through it, in doing which portions of it become enveloped in thin films of mucus, constituting bubbles, which, breaking on the surface of the fluid, generate particular moist sounds, recognised as the mucous and submucous rhonchi. These sounds gradually take the place of the dry, or sonorous and sibilant, rhonchi of the previous stage, and in this respect afford satisfactory evidence of the progress of the disease.

The quantity of mucus at first discharged, directly after the establishment of secretion, is small; but it rapidly increases until four, six, or eight ounces are expelled in twenty-four hours. As the congestion of the membrane is in this way removed, the colour of the latter declines, until with the complete cessation of disease the natural hue is regained. The microscopic examination of the secretion shows this variety of bronchitis to be of the mildest form, and confined to the epithelial coat.

From the absence of all inflammatory exudation in the bronchial secretion, there is, I think, sufficient ground to conclude, that the submucous tissue is not affected, and that the disease consists in an excessive nutrition, arising out of an overplus of nutritive blastema supplied to the basement membrane, and consequently exciting inordinate cell-growth in its epithelial covering. Hence the opinion of Dr Williams, that—"The more intense form of acute bronchitis differs from the milder kind already described in the greater extent of the bronchial tubes which it occupies rather than in pathological character," is not strictly correct, inasmuch as, in the milder kind (epithelial bronchitis), there is presumptive evidence that the submucous tissue is not the seat of exudation; whereas, in the severe kinds of bronchitis, inflammatory exudation invariably occupies that structure.

The secretion, in its simply physical character, resembles at first a thin viscid fluid, similar to the white of egg considerably diluted by admixture with the solution of an alkali. When, however, a quantity of it is collected together in a vessel, it is sufficiently tenacious to form a mass, which adheres to its sides, and which quits them, on inverting the vessel, in long, ropy, stringy portions or bands.

Microscopically examined, it consists of well-formed mucus-corpuscles, mingled with epithelial or basement patches, floating in a viscid fluid menstruum—the contents of cells which have already liquified. The epithelial or basement patches are chiefly present in the first portions of the secretion, and are caused by a blighting of their cells by the suspension of the natural fluid transudations from the blood through the basement membrane during the previous stage of the disease. Sometimes these patches are formed entirely of epithelial cells which have almost attained a perfect development, but which yet cohere by their edges, as is shown in the adjoining figure.

Fig. 7.

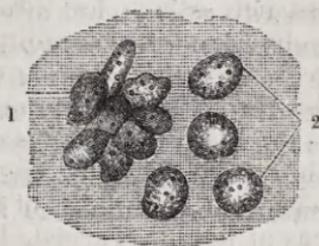


Fig. 7.—1. Epithelial patch.
2. Mucus-corpuscles.

Had such patches of cells retained their position on the basement membrane a short time longer, they would have undergone a further trifling increase of growth, at the expense of the shred of basement membrane which yet intervenes between their edges, after which they would have fallen apart and become separate, isolated, and distinct cells. While thus united, they, in general, measure from $\frac{1}{2800}$ th to $\frac{1}{3100}$ th of an inch; but when they have attained full growth, and exist as separate and distinct cells, they have a diameter from $\frac{1}{2000}$ th to $\frac{1}{2500}$ th of an inch.

Their outline is now well-defined, and their surface, which presents a full and globular appearance, shows numerous granules, which have an average diameter of $\frac{1}{18,000}$ th of an inch. Acetic acid and liquor potassæ produce the particular effects upon these structures before described.

Occasionally, although not very often, the action of the cilia can be seen on the surface of mucus-corpuscles which have just been expelled. In one instance of epithelial bronchitis, I watched this movement, on the surface of a fully developed mucus-corpuscle, for twenty minutes, at the expiration of which time the action entirely ceased. During this time the movement did not appear to take place exclusively in one direction. For some minutes the action of the cilia was rapid, and in a direction which caused the extremity of each cilium to move in a circle; then this kind of motion ceased for a minute or two, and was succeeded by a backward and forward movement, the cilia during the whole of this time exhibiting a vermicular motion from base to apex. This alternation of movement continued for fifteen minutes, the whirl movement predominating at the commencement, and the to-and-fro towards the close of this period. Both were succeeded, during the last five minutes, by a slow oscillatory motion, which gradually subsided, and at length entirely ceased.

If we compare the chemical composition of the secretion in epithelial bronchitis with that of the secretion discharged by the healthy action of the bronchial membrane, we find that, after the full establishment of the second stage of the disease, it is exactly

similar. When expectoration is just commencing, the secretion contains a less amount of solid constituents than healthy mucus, apart from all admixture with saliva; but after the first flush of discharge is over, the composition of the two secretions is as nearly alike as possible. But the quantity of mucus discharged in epithelial bronchitis, within a given time, greatly exceeds that of health; and in this fact consists the essential difference between the healthy action and the pathological condition of the bronchial membrane now described. The curative indications to be thence drawn have for their object—

1. To diminish the supply of nutritive blastema to the basement membrane, and thereby to limit the amount of cell growth upon its free surface.

2. To restore the vital tonicity of the bronchial capillaries, and thus to enable them to reduce their quantity of blood to their healthy standard.

The first indication is to be fulfilled by as much abstinence as is practicable from food of every description, as well as from drinks, however simple; and by exciting other secretions, by which the afflux of blood to the bronchial membrane is not only lessened, but the actual quantity of blood in the system is diminished. By nice management of this kind, a few days' treatment will effect a cure; and hence the statements of different authors, that the duration of bronchitis is from four or five days to as many weeks. The former period is applicable to the epithelial bronchitis—the latter to that in which exudation involves the submucous tissue; for when once exudation has taken place into the last-mentioned structure, it is impossible for the whole of it to be removed in a few days.

The second indication of treatment is fulfilled by the breathing of a light, dry, *cool* air, which gradually excites the relaxed capillaries to a healthy tonicity. Very cold air, so beneficial in the previous pathological condition, would in this be a great evil; because the vital tonicity of the bronchial capillaries is, in a great measure, exhausted; and the excessive stimulus of cold air, like the excessive application of heat in frost-bite, would only add to the exhaustion, under which they (the capillaries) would again become excessively distended with blood, and consequent partial suppression of secretion and corresponding stricture of the bronchial tubes would arise. To the latter effect spasm of the muscular fibres of the bronchi would contribute, owing to their retaining sufficient excitability to respond to the stimulus of cold air. From the foregoing considerations, we may deduce the general law:—

That, for the healthy manifestation of a function, the capability of action must be proportionate to the amount of stimulus employed.

On this principle, then, moderately cool air is applicable to the second pathological stage of epithelial bronchitis, in which it gradually excites the yet inherent power of the capillaries, and thus

favours their return to a normal condition. To this end blisters likewise contribute, by (1) the derivation, or rather the diversion, of blood to the surface which they excite, and by the quantity of fluid abstracted by exudation, by which the quantity of blood passing through the lungs is lessened; and (2) by a reflex motor impulse transmitted to the bronchial capillaries, by which the contractility of these vessels is again roused to activity. With this view also, mild tonics, coupled with sedatives, are beneficially exhibited, when the general excitement of the system has subsided; because they not only give tone to the general system, and to the bronchial capillaries, by which the latter are enabled to regain their natural diameter, and thereby to furnish a healthy amount only of blastema to the basement membrane, but they at the same time allay irritation, control inordinate cough, and thus prevent sudden congestions of the lung so frequently arising out of the latter cause.

It has already been shown that the alkalies have the property of liquifying mucus, of destroying to a certain extent its viscidty, and consequently of rendering it more easy of expulsion from the bronchi. Their use, therefore, is indicated in every case of bronchitis from the moment of its passing into the second pathological stage. Potassio-tartrate of antimony, on the other hand, when mixed with mucus, clots it in the same manner as do acids, and, like them, it partly destroys the tenacity of mucus. It would, consequently, be a very proper remedy for the second stage of bronchitis, were it not that its powerfully depressing and relaxing influence on the capillary system of vessels would tend to maintain the very condition of the bronchial capillaries which it is the object of the treatment, during the second pathological stage, to rectify. As soon, therefore, as expectoration is fully established, the tartrate of antimony should be discontinued; but, until such is the case, no remedy in the whole range of the materia medica can exert a more beneficial effect in this direction.

For the use of expectorants, strictly considered as such, there is no pathological indication in this variety of bronchitis. Their consideration may, therefore, be deferred until I treat of those pathological conditions to which they are suitable.

Other and minor, yet essential, points in the treatment refer to cough, exercise, use of the voice, and food and drink, during the latter part of this stage, in the management of which the object should be—to keep down vascular action, to prevent pulmonary congestion, and to restore the vital tonicity of the bronchial capillaries. By inducing this last-mentioned condition, a normal quantity of blood only is supplied to the bronchial membrane, the healthy functions of which are consequently restored.

(To be continued.)