THE LUMLEIAN LECTURES ON SOME POINTS IN THE NATURAL HISTORY OF PRIMITIVE DRY PLEURISIES.

Delivered at the Royal College of Physicians of London.

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LECTURE II.

A CAREFUL study of the cases related with more or less completeness in my first lecture, leads naturally and necessarily to the second stage of this inquiry. A full understanding of the clinical demands a solution of the pathological problem. They are inseparably connected, and find their common origin in dynamic disturbances, which, although sometimes intangible, invisible, and incalculable, constitute the ultimate nature or essence of disease. What, then, is the nature of the visible pathological changes originating, underlying, maintaining, and continuing the symptoms and signs characteristic of the course and issues of the cases set forth as the grounds of this inquiry? But, before describing those changes as I have observed them in the course of my examinations, I must clear the way to the better understanding of them by some remarks on the minute anatomy of the lung, and on the structural characters of a blood-clot formed in freshly drawn blood.

Setting aside the earlier, and in sundry ways admirable, accounts of the minute anatomy of the lung given by Addison, Rainey, Rindfleisch, Schultze, Charot, Sappey, Lefort, and Waters, and confining our examination to the accounts more recently published by such observers as Schäfer and Klein, we shall learn from them the views received and adopted at the present time. Here is what Schäfer says (*Quain's Anatomy*, vol. ii, page 514). "After a certain stage of subdivision, each bronchial tube reduced to a small size is termed a lobular or respiratory bronchial tube, and its walls become beset with small hemispherical sacculi termed air-cells or alveoli. They occur at first only here and there, and confined to one side of the tube only, but at length almost cover it, so that the tube in a great measure loses its cylindrical character. At length it ends in an enlarged completely sacculated passage termed the alveolar passage, from which are given off blind ramifications, somewhat enlarged towards their extremities, and everywhere closely beset with the air-cells. These enlarged terminations are named infundibula." In order to give as exact an expression as possible of these views, he illustrates them by a diagram given at page 516 of the work already cited. From Klein's *Atlas* and from his more recent masterly little *Handbook of Histology*, I extract the following account, which, on the whole, is the simplest, clearest, and most accurate of any hitherto published concerning the minute anatomy of the pulmonary parenchyma. "The small or intralobular bronchi are cylindrical tubes. They divide dichotomously into smaller tubes, and ultimately pass into the alveolar ducts, which take up on all sides of their circumference the lateral alveoli; the ultimate parts of the alveolar ducts are the infundibula, which take up the terminal alveoli. The alveoli are spherical or polyhedral in shape; and those belonging to the same alveolar duct or infundibulum are separated by much less tissue than the alveoli of adjacent lobules." In the *Handbook* (p. 220), it is further said "that all ducts or infundibula are closely beset in their whole extent with spherical, or being pressed against one another with polygonal vesicles—the air-cells or alveoli—opening by a wide aperture into the alveolar duct or infundibulum, but not communicating with each other. The infundibula are much wider than the terminal bronchioles, and also wider than the alveoli."

To Rainey, and to both these distinguished observers, is due the merit of having cleared away much of the confusion in which this intricate subject was until recently buried, of having discarded a complex, misleading, and useless terminology, and of having made it possible for persons not investigators or experts to form a tolerably accurate and clear conception of the anatomy of the pulmonary parenchyma and of its relations to the larger air-passages. But even yet the reform is incomplete. It is not enough to have swept away, as

mere subjective expressions, such terms as primitive and secondary lobules, lobulettes, air-sacs, and the like. Others, supported by great authority, remain; and, whilst either having no correlative facts, or conveying inaccurate representations of those really existing, they suffice to keep obscure that which is simple, and to render barren, or fertile only in error, the application of anatomical facts to pathological processes and practical work.

Schäfer, for example, speaks of bronchia, bronchioles or respiratory bronchial tubes, of their endings in enlarged completely sacculated alveolar passages, and of the giving off from them of blind ramifications or infundibula, enlarged towards their extremities, and everywhere closely beset with air-cells. Elsewhere, he says: "At the end of the respiratory bronchioles, near the passage of the infundibula, all the cells which line the wall of the tube are of the non-ciliated pavement variety. But the air-cells themselves, both those which are scattered over the respiratory bronchiole, and those which cover the infundibula, as well as intermediate portions of the infundibula, which occur here and there between the air-cells, possess an epithelium of a peculiar character."

Now, in this quotation, even with the help of the context, it seems to me impossible to find a clear, connected, and exact account of the terminal air-passages, and of their relations to the pulmonary alveoli. And this impossibility, as I view it, lies less in any error committed by this distinguished anatomist than it does in the multiplication of distinctions, forgetfulness of the archetypal idea of a respiratory organ, and the use of terms which are at once confusing and useless. There are two necessary, and, as it happens, they are the only unerring, guides to the complete and accurate understanding of the structure of an adult organ. The first is the study of its comparative history throughout the animal series; and the second is the study, from beginning to end, of the course of its own development. Investigated after this manner, the difficulties encountered in understanding the minute anatomy of the lung disappear; and the relation of the air-passages to the alveoli becomes so clear, and easy of apprehension and expression, that the use of many and complex terms is neither necessary nor justifiable. The primitive type of a lung is a cylindrical tube, the sides and end of which are portioned out by delicate membranous septa into shallow cubical spaces, not communicating with each other, but only with the common lumen of the tube round which they are arranged. If one will imagine a corridor, with open cubicles fully occupying not only each side, but the further end, the floor, and the roof; if one will also imagine that no free space is left between the cubicles, that they fully occupy the sides, roof, floor, and end of the corridor, that they do not communicate with each other, except through the corridor around which they are arranged; that the corridor imagined is surrounded without loss of space on every side by corridors and cubicles similarly arranged; that all these corridors lead outwards to the exterior of the house of which they form a part; that, as all these corridors run outwards, they are joined by others without enlarging through the junction; and that at first the corridors are so short as to have only a single or double row of cubicles, whilst further outwards they have three, four, or even more—if you will imagine all these things, you will be able to frame a sufficiently clear and accurate conception of the simple way in which the pulmonary alveoli are connected with the pulmonary air-passages, and these with one another.

To describe the relation of the air-passages to the alveoli in a more formal and literal manner, we may take a lobule as the subject of description. Each lobule, more or less conoidal in shape, surrounded by areolar tissue with all its usual contents, and penetrated at its smaller end by the lobular bronchus, and by blood-vessels, lymphatics, and nerves, constitutes, as we know, a miniature lung. As soon as the terminal bronchus enters the lobule, it divides and subdivides with increasing rapidity, and but small diminution of size, until the dividing or branching process is brought to an end at the circumference of the lobule. At its entrance into the lobule, the lobular bronchus is but scantily alveolated, and its direction is moderately straight; but, in the second and third divisions, which diminish in size, the walls are alveolated throughout, and the direction is constantly changing. In the terminal portions of the air-tubes or passages which do not diminish in size, the division is extremely rapid, and the end of each passage is formed by its abrupt closure just beyond a final division. It is this fact which, when a section of lung, including the pleura, is examined from the deep surface, has led to the notion that the terminal passages or tubes form dilatations or sacs at their blind extremities. Fortunate sections and dissections parallel to the long axis of a passage demonstrate this notion to be incorrect.

If this view of the relation of the air-passages to the alveoli be accurate, and long study of the subject makes me somewhat confident

about it, there is no need for a complex and copious terminology. It will be enough to speak of the lobular bronchus, of the intralobular bronchi or bronchioles, of the interalveolar passages, and of the alveoli.

The alveoli are almost always spoken of as being hemispherical or vesicular; and their relation to the air-passages is often illustrated by reference to a racemose gland or to a bunch of grapes. Both the description and the illustration are alike erroneous and misleading. It is true that, under forced inflation, and as a result of injection and of other manipulations, the alveoli do exhibit, occasionally, a distantly hemispherical shape; but this is abnormal. Lying on the walls of the terminal passages, varying a good deal in size, and somewhat in shape, but fairly uniform in depth, they can be best described in the main as irregular cubical spaces. A single layer of a honey-comb rolled into a cylindrical tube, and closed at one end by another single layer, the cells of both looking inwards, would illustrate better than anything else that I can remember, the relation of the alveoli to the interalveolar passages.

By carefully inflating and drying a portion of lung, and examining sections of it made at varying angles to the pleura under an inch objective attached to a binocular microscope, the statements now advanced with respect to the relation of the alveoli to the interalveolar passages may be easily corrected or confirmed by any competent observer.

These remarks on certain points in the minute anatomy of the lung have led me from the main subject of inquiry further than I intended or desired. I excuse myself on the ground that an accurate and adequate knowledge of this subject is essential to the just understanding, not only of pathological processes, but also of those respiratory sounds which we employ in the diagnosis of disease.

If a little freshly drawn blood be dropped upon a glass slide, permitted to clot, decolorised by gentle washing, and submitted to microscopic examination, three things, and their mode of combination, will arrest the attention of the observer; a basis-substance, arranged by wrinklins or foldings into varying sized areolæ; a faint and close network made up of minute molecular-looking fibres; and a small number of leucocytes. The fine fibrillar network will be seen to occupy the spaces enclosed by the areolæ of basis-substance. The leucocytes, imprisoned in the basis-substances, or in the fine fibrillar network, and undergoing some granular change, appear to be shooting out in all directions protoplasmic process, and to be engaged in textural development. On examining such a specimen without any knowledge of its nature, it could be easily mistaken for a delicate glioma, and would be unhesitatingly received as a conclusive example of the development of fibrous tissue from leucocytes. But a further critical study of such a specimen will make it certain that no such development is taking place; that both the areolar basis-substance and the fibrillar network are formed directly from the liquor sanguinis; that the leucocytes and their processes are in the way of degeneration; and that, whilst they and the fibrillar network will melt into a granular *débris*, the basis-substance will remain unchanged.

I have related this experiment to show how easily one may be deceived by appearances when they run along the line of one's ideas, and how much care is needed in interpreting the changes which occur in recently exuded lymph. In this matter, three structural elements are to be found—a fibroid basis-substance, fibres, and cells. The latter are either migrated leucocytes or proliferating connective tissue corpuscles; and it is held that from one or other, or both, the fibroid substances and the fibres are developed; and that the idea of the direct formation from an exudation of any sort of fibroid tissue must be definitely abandoned. In respect of the fibres formed in some kinds of lymph, this contention is doubtless correct; but, in respect of the fibres formed in at least one kind of lymph about to be mentioned, no conclusive evidence has been adduced. In those exudations which consist of a fibroid basis-substance and imperfectly formed white fibrous tissue, this theory cannot justly be maintained.

It is true that there are present in them leucocytes, and sometimes a few fusiform cells; but it is equally true that they do not exist in such numbers, nor show such changes of transition into fibroid materials, as would warrant the inference of an exclusively causal relation between them. In such instances, as in the instance of the blood-clot, one may fairly hold that the fibroid elements have been directly formed out of the exudation, and that the cells present therein have taken at least no structural share in their development.

Leaving these collateral considerations, I proceed now to consider the chief forms of exudation produced in the course of primitive dry pleuritis. These exudations may be classed under three heads; the fibrinous, the croupous, and the proliferative.

1. The *fibrinous exudation* is characterised by the scarcity of its cell-forms and its permanency; the croupous, by the abundance of its cell-forms and their rapid degeneration; and the proliferative, by the abundance of its cell-forms and the rapidity and variety of their structural developments. In no case does any one of these forms constitute the entire exudation; but in every case one variety predominates and determines the characters and the course of the changes which ensue.

In its early stage, the fibrinous exudation consists of membranes more or less extended, and more or less thick, which can be detached from the pleura without apparent injury to its epithelial surface. This membrane is greyish, sometimes semitransparent and elastic, but friable. It does not often adhere to the costal pleura, and it is more frequently found over the upper than over the under part of the lungs; indeed, its most frequent seat is around the summit of this organ. It is composed of a basis-substance studded with moleculogranular matter, shaped into rude areolæ, or differentiated into bands of imperfectly formed fibrous tissue; and it contains embedded in it a few epithelial-cells, some oat-shaped nuclei, and here and there a nucleated fusiform cell. Sometimes the exudation presents the appearance of an irregularly honeycombed or reticulated membrane, in the meshes of which there is found a yellowish glutinous fluid, clotting on exposure to the air. In this fluid are found amorphous flakes, leucocytes, and red blood-discs. The structural constitution resembles that of the smooth membranous exudation; but it cannot be so easily removed from the pleura; and whereas the subpleural areolar tissue is, in this instance, congested, swollen, and infiltrated with a fluid containing many leucocytes, it is, in the former instance, apparently little, if at all, affected. At a later stage of its existence, this fibrinous exudation becomes denser, harder, tougher, extends into the pleural matrix, and now, opaque and yellowish, cannot be detached without injury from the pleural surface. The subjacent pulmonary alveoli are for the most part little affected, but here and there their walls are thickened without apparent proliferation, and their cavities contain a fibroid substance with epithelial cells and leucocytes embedded therein. At a later stage, however, when the fibrinous exudation invades the lungs, further changes take place. This invasion, when it takes place, moves in the first instance along the lines of the interlobular fissures, and only at a later period steals along the blood-vessels into the alveoli. In well marked cases, three striking naked eye changes slowly appear in the wake of this invasion. The interlobular areolar tissue at the affected part is converted into thickened and indurated bands, which, in some instances, contracting and compressing the lobules, give rise to the appearance, rather rare, of a true pulmonary cirrhosis. In the second place, portions more or less extended of the pulmonary parenchyma become solid, hard, tough, dark, and creak under the knife, which cuts them with difficulty. And, in the third place, along the course of the fibroid invasion, adjoining the consolidations, and at various parts of the summit and free margins of the lung, there are tracts or patches of vesicular emphysema. In the summit of a lung in which limited tubercular growths have undergone fibroid substitution, all these changes, the thickened pleura, the fibrous bands, the small consolidations, and the emphysematous patches, will be found side by side.

In addition to these changes, others less obvious will be found upon close examination. One of them is thickening of the adventitia and intima of the pulmonary arteries, and the growth from the intima of minute fibroid nodules, which sometimes fill the cavity of the vessel. Another change is thickening of the alveolar walls, with the development therein of free nuclei, not apparently engaged in tissue-development. A third change is the appearance in the fibrous bands, chiefly at their intersections, of small fibrous nodules, which resemble, and are considered to be, true grey granulations or tubercles. But neither the structural characters of the nodules, nor the history of the patients in whom they are found, justifies this interpretation. They are composed of a fibroid basis substance, having imbedded in it numbers, never large, of small free ovoidal nuclei, a few nuclear fibres, and rarely a little elastic tissue. Each consists of one mass, and not of several masses; it does not, as far as I know, contain giant-cells; and it never undergoes the cheesy change. Akin to these little nodules, there are sometimes found, in cases of long standing where there have been repeated exudations, larger lumps or flattened masses of like characters connecting the visceral with the parietal pleura, and looking like growths from which it is not always easy to distinguish them.

The pleura, once the subject of fibrinous exudation, is liable to fresh attacks of inflammation, and to the formation of new membranes, superimposed upon the old. These new layers, although resembling each other in structure, are never completely fused into one,

and on section can be easily distinguished. Between the layers there are left spaces of various sizes, filled with a glutinous fluid, containing epithelial cells, leucocytes, and a few fusiform nuclei. These spaces are coated with an interrupted epithelium, and distantly resemble lymphatic sacs. This is the form eventually assumed by the reticulated fibrinous exudation when it is permanent. When only a single thin layer of this fibrinous exudation exists, vessels are not found in it. Even when there are several layers, vascularisation, as compared with the proliferative exudation, is exceedingly scanty; and it seems probable that the development of new vessels takes place rather by channelling and differentiation, than by development through the medium of protoplasmic cells.

Lastly, this form of exudation is characterised by the scantiness of its cell-constituents, by the slowness of the changes occurring in it, by its persistence, by its freedom from complication with caseous consolidations and bronchial dilatations, by the lines which it follows in invading the lung, by the rarity of its disintegration thereon, and by the insignificance of its effects upon the general health.

2. The *croupous*, or, as it was originally named by me, the *corpuscular exudation*, occurring in primitive dry pleuritis, differs in many ways from the fibrinous on the one side and the proliferative on the other. It occurs for the most part at the middle and lower parts of the lung; it is yellow, soft, thready, unelastic, and full of fluid, containing multitudes of degenerating cells, hyaline globules, blood-disks, amorphous flakes, fragments of granular fibres, granular debris, and countless micrococci. Sometimes, without the occurrence of pneumothorax, these accumulations escape by means of minute openings in the pleura, through the lung, and the patient recovers. A single exudation examined more closely may be divided into three parts. The first is an opaque, yellowish, and friable membrane of varying thickness, incapable of detachment from the subjacent pleura, with which it is apparently organically incorporated. The second is a loose, open, soft, areolated pseudotexture, infiltrated with fluid. The third, occupying the free surface of the exudation, consists of incohesive, soft, fringe-like processes, which often break on handling. There is seldom any strong adhesion between the costal and the pulmonary pleura. When the exudation is very abundant, and occupies a considerable space between the viscere and parietal pleura, circumscribed portions of it are sometimes found broken down and occupied by a fluid resembling pus. For the most part, this fluid is not pus—not a fluid holding in suspension spherical globules of uniform size, structure, and mode of response to re-agents—but a fluid holding in suspension disintegrating leucocytes and epithelial cells, granule cells, and hyaline spheres, oat-shaped nuclei, and broken fusiform cells, fragments of fibres and granular debris.

The lung adjacent to the inflamed pleura is always affected to varying depths and in different ways. All the alveoli are congested, and contain desquamated epithelium and leucocytes. A few, but in my experience always a few, groups of alveoli are found in a state of red hepatisation. Larger and much more numerous groups of alveoli are in a state of caseous consolidation. In the subpleural areolar tissue, in the interlobular fissures, and occasionally at the entrance of the vessels into the apex of the lobule, small yellowish nodules are seen, and may be commonly traced to lymphatics, from the proliferation of which, or of their contents, the nodules appear to arise. They are composed of an adenoid reticulum and of areolæ of common fibrous tissue, in the meshes of which are found masses of lymph-corpuscles, free, rounded, or oval nuclei, nucleated fibres, and numerous multi-nucleated cells in a state of active endogenous proliferation. Resembling in some ways tubercular nodules, they are often declared to be tubercles.

A close examination of the outer surface of one of the earliest formed layers of exudation will sometimes bring to light the existence of two sorts of minute openings. The one are stomata, chalice-shaped cavities, with epithelial lips and linings, leading into lymphatic spaces. The other are minute openings, the mouths of burrowing and sometimes branching tunnels, which occasionally can be followed into the pulmonary alveoli. It is not improbable that, when a croupous exudation melts, it sometimes makes its way through these tunnels into the lung, and is thence discharged. In a case which I recently attended with Dr. Barnes and Mr. Merriman, a puerperal pleuritic croupous exudation led, by melting, to the formation of three small encysted empyemas. Paracentesis having been considered inexpedient, the pyoid collections were left to nature. After a week, in the neighbourhood of one of the sacs, there was heard a coarse moist crepitation; a few days later, the crepitation became a bubbling rhonchus; and shortly afterwards, some ounces of a pyoid fluid, quite different from genuine pus, were expectorated. The same procession of events attended the emptying of each sac. Meanwhile, there was no single

sign of pneumothorax; and, although the thoracic walls corresponding to the empyemas were bulged, there was no displacement of the heart or of other organs. The patient is now completely convalescent.

Sometimes this pleuritic croupous exudation has a constitutional origin, and then the affection may be bilateral.

With a low capacity for organisation, this exudation exerts at times a considerable influence for evil on the subjacent lung. The effect consists sometimes in disseminated caseous or lymphoid consolidations, sometimes in fibroid changes, and sometimes, although rarely, in small excavations or in bronchial dilatations. Basic lung-disease, akin to that described by Mitchell Bruce and others, now and then arises in this manner.

The issues of this exudation are, in at least one respect, remarkable.

When the case pursues a favourable course, the exudation is for the most part entirely absorbed; and I have once or twice learned from examination after death, that within a few months of an attack, every vestige of its presence has been removed. Now and then the fluid part of the exudation is absorbed, and the residue, becoming dry, undergoes caseation. In this condition, calcareous plates and particles are occasionally deposited in it, and the patient becomes subject to obscure and often recurring attacks of pain.

3. The *proliferative pleuritic exudations* which I now proceed to describe, are of more frequent occurrence than the other two, more varied in their course, and more enduring in their larger issues and effects. They are still further distinguished in their origin from fibrinous and croupous exudations. For, whilst the latter are preceded by the phenomena of inflammation, and accompanied by an abundant fluid exudation, the former sometimes arise, increase, invade the lung, and undergo textural changes unaccompanied by any other phenomena except those belonging to a slow and simple textural growth. Indeed, this variety of proliferative exudation often passes almost imperceptibly into pleural new growths, and further on I shall have to advert to several cases of this kind.

Beginning in the subpleural connective tissue, and accompanied from the first by active cell-proliferation, this exudation passes through the pleural matrix in two ways. Accompanied, as is usually the case, with an abundant fluid plasma, the exudation reaches the pleural surface without apparent breach of continuity. Unaccompanied by any such fluid, proliferating cells, arranged in pointed groups, push their way through the pleural matrix, and, making breaches of continuity therein, reach the epithelial surface, spread rapidly thereon, and unite to form a continuous proliferating new membrane, which at various parts differs in aspect, consistence, and thickness. The even membranous form, however, is not always maintained. Sometimes, when the masses of cells and fibres are loosely disposed and soaking in a glutinous fluid, the free surface assumes the honeycombed or alveolated appearance already described in connection with fibrinous lymph. Sometimes, when accompanied by any fluid, the free surface becomes studded with clusters of granulations, nodules, or sessile warty-looking lumps; sometimes it is clothed with papillæ, or with fringe-like branching processes. In either case, adhesions are speedily contracted with the costal pleura, and the intervening space becomes slowly filled by the connecting bridges, bands, or masses of actively proliferating lymph. The meshes of the exudation become filled with fluid; and, when the meshes are large and the fluid abundant, the movements of breathing heard when listening to the chest with a stethoscope beget *râles*, which are difficult to localise and understand. After a time, the whole space between the pleural layers becomes filled with a solid exudation, and this, increasing in density and in hardness, becomes, with the visceral and costal pleura, fused into a tough, unyielding, fibrous, reticulated, and laminated mass.

The structure of this exudation varies with its age. In the beginning, or, at least, as soon as it can be examined, it consists of an obscurely fibroid, and sometimes areolated, basis substance, of a close network of fine molecular-looking fibrils, of leucocytes, nucleated cells, fusiform fibre-cells, and desquamated epithelium. In addition to these elements, there are always present, in varying amount, oval or oat-shaped free nuclei, red discs, and a few hyaline spheres. After a short time, the network of molecular fibrils entirely disappears, the basis substance remaining becomes more distinctly fibroid, and constitutes a fundamental support for other changes in progress; leucocytes, or round cells resembling them, increase; fibre-development from cells advances; new vessels shoot out in various directions; active cell-proliferation subsides, and the bundles of freshly formed fibrous tissue become arranged either in lamina, when they sometimes exhibit a striking resemblance to unstripped muscular tissue, or in areolæ, through which communication with lymphatic spaces or channels is ultimately established.

But whilst development has been thus proceeding towards the costal pleura, it has been also, in a certain number of cases, advancing into the substance of the lung. In the first instance, it is only the subpleural alveoli which are affected, and their first mode of affection is a croupous, or, more rarely, a caseous consolidation. Later on, the proliferating exudation steals along the interlobular fissures, consolidating the peripheric alveoli of the lobules, seizes upon the peribronchial and circumvascular connective tissues, enters the lobules of their roots, and travels along the terminal air-passages, blood-vessels, and lymphatics, into the alveoli. During this time, the proliferating exudation consists essentially of two parts, constantly varying in their quantitative relations to each other—of the proliferating and fibre-growing cells, and of the fibroid basis-substance already described. Sometimes, without obvious reason, the one predominates; sometimes the other; but they always concur; and, when the alveoli are affected, the cellular part always predominates in their walls, and the fibroid in their contents.

In the course of this progression of the exudation from the superficial to the deep parts of the lung, and from the root or from the circumference to the centre of a lobule, all the pulmonary tissues become affected; and the kind and degree of the affection determine the aspects which the lung shall afterwards assume, and the course which the malady will eventually pursue.

It may be said, in a general way, that the first effect upon the pulmonary textures consists in vascularity and swelling; the second, in hardening and contraction; and the third, in caseation and destruction, or more often in destruction without caseation. According to my own observations, they may, in abstract, be described in the following manner. The interlobular areolar tissue, increased in vascularity, swells, proliferates, hardens, and develops occasionally in its midst, either small, tough, fibrous looking knots, or minute lumps and lines of cheesy stuff. Increasing in breadth, the interlobular septa encroach upon the lobules, and compress them in various directions; and at the root of a lobule, where the bronchus enters, and the vessels enter and emerge, the parts become so constricted by the fibroid invasion, that their nutritive and functional activities are seriously depressed, and the integrity of the lobule as an organ is put in growing peril. The smaller branches of the pulmonary artery are greatly thickened by proliferative swelling of the outer and inner coats; and the latter, coming to look like a richly nucleated laminar fibroma, develops on its free surface granules or nodules, sometimes large enough to obstruct the lumen of the vessels. Some of the capillaries are obliterated, some are dilated, some aneurysmal, but all are thickened, and in many the centres of their endothelial plates are occupied by larger or smaller groups of proliferating free nuclei imbedded in a fibroid substance. The terminal bronchi, in the midst of the indurating exudation, are affected in divers ways. Sometimes they are thick, hard, and compressed; sometimes they are soft, loose, thin, and generally or locally dilated. There is, however, almost always thickening of the adventitia, with the occasional deposit of minute caseous lumps therein; the muscular coat is in a state of degeneration, or undergoing fibroid substitution; the elastic bands are still undisturbed; and the mucous membrane, congested, infiltrated with a fibroid basis-substance, and studded with oval and oat-shaped nuclei, has, for the most part, lost its ciliated epithelium, which is replaced by a layer, or layers, of columnar, cuboidal, or flattened cells. The alveolar walls are irregularly thickened; the intercapillary spaces are occupied by a nucleated fibroid tissue, which, at one part, destroys a portion of the capillary network, and at another projects into granulations or nodules; the alveolar endothelium is replaced by layers of subspheroidal or flattened cells; and the alveolar cavities already encroached upon by the thickened walls are, at some points, occupied by masses of a fibroid substance, with a few round or oval nuclear particles therein. From the concurrence and co-operation of these and other structural changes, the affected portion of lung is at length brought into a condition which practically, if not theoretically, must be regarded as a pathological autonomy or entity. In this state, the affected portion of lung, encapsuled by layers, more or less numerous and thick, of indurated pleural lymph, diminished in size and irregular in form, heavy, dense, tough, and uncrepitant, feels like a mass of India-rubber of unequal thickness throughout. The surface of a section made through such a lung, intersected by fibrous bands, springing from and returning to the thickened pleura, and broken by the patulous mouths of bronchi and blood-vessels drawn closely together, is of a dark reddish slate-colour, veined between the septa with whitish branching lines, studded with fibrous knots or caseous granules, and closely spotted with muco-purulent points. Cut with difficulty and creaking under the knife, the affected lung, when compressed, yields from the

smaller bronchi larger or smaller quantities of inspissated pus, and, from the parts between, a sometimes scanty, sometimes abundant serum, rich in blood-discs, leucocytes, pus-globules, nucleated cells and fibres, hyaline and granule spheres, and free nuclei. Under various names, and ever since pathological anatomy has been cultivated, this condition of lung has been a subject of discussion among pathologists. It is the grey induration of Andral and Addison, the pulmonary cirrhosis of Corrigan, the fibroid pneumonia of Sutton, Bastian, Moxon, and Wilks, and the chronic interstitial pneumonia of Charcot, Wilson Fox, and Hamilton. Furthermore, this fibroid induration represents in part an early stage of the condition of lung eventually developed by the habitual inhalation of irritating particles of coal, dust, stone, or steel.

For an indefinite time, and even beyond the average duration of life, this condition of lung may, in favourable circumstances, remain stationary, and be found compatible with fair health, and all the ordinary duties and enjoyments of life.

But circumstances are not always favourable. In failure from any cause of the general health, and especially under the influence of recurring irritations of the respiratory passages, the various changes constituting the fibroid lung advance, and out of them, by metaplastic or by other methods, new ones arise. For a time, the new and advancing changes are still compatible with tolerable health. But sooner or later they assume a regressive character; the tide of action turns against the organism, and by slow degrees it succumbs. Examined at this stage, the lung exhibits, in addition to the alterations already described, sundry new ones. These are minute accumulations of fat, patches of vesicular emphysema, excavations of various forms and sizes, and, in an uncertain but not large number of cases,¹ cheesy masses and bronchial dilations. To some of these alterations I shall devote a few remarks. Unquestionably, some of the emphysemata present in the fibroid lung are the results of physical forces acting in well defined conditions. But a certain number arise in a different manner, and for the most part they are to be found in the midst or on the borders of the fibroid indurations. It is probable that these emphysemata are produced by more or less complete obstructions of minute branches of the pulmonary artery. For, in certain experiments which I performed some years ago, I found that, by injecting sand or finely powdered glass into the jugular vein, and so producing embolism of some of the intralobular branches of the pulmonary artery, fatty usure, and then emphysema, followed in the territory supplied by the blocked vessel.

Of the excavations or dilatations met with together or separately in the degenerating fibroid lung, three deserve notice: the fibroid, the caseous, and the bronchiectatic. The simple or fibroid excavations are small, elongated, irregular, and contain a thin and, sometimes, blood-stained pus. When comparatively recent, the surface of the cavity is soft, shaggy, and congested; it is composed of mere fibroid stuff in a state of dissolution, and of fragments of the elastic areolæ of the alveoli, which, seen by the help of a simple lens, hang from it like bits of tangled thread. When of ancient date, the interior of the cavity is smooth, vascular, and apparently formed by an organised membrane; it is, however, nothing more than an infiltration and induration of the lung-substance immediately surrounding the cavity; and although the cavity in some sense secretes, its enlargement proceeds by disintegration of the free surface, and a less proportionate "filling in" from behind. The contents of this form of cavity, never a true pus, is produced in some degree by metaplastic processes, but in the main by degenerative and necrotic changes. Unless when old and stationary, elastic areolæ and the *débris* of disintegrated blood-vessels are always to be found in the contents. The caseous excavations are small or large; the small excavations appear to be formed by a process of necrotic dissolution pure and simple. In the interlobular fissures, they seldom extend, and almost always heal, through secondary fibroid processes. The large caseous excavations are also, in the main, produced by the chemical changes which finally determine necrotic dissolution; but, in a small degree, proliferative and metaplastic processes concur, and hence the presence in such cavities of pus-globules, free nuclei, and nuclear fibre.

The caseous masses sometimes found in the interior of the fibroid lung vary much in size: sometimes about the size of a garden pea, they are occasionally larger than a walnut. They are composed principally of epithelioid cells, and in small part of leucocytes, of free nucleated bodies, and of much granular *débris*, pervaded occasionally by an obscurely fibrillated basis-substance. They arise plainly enough in proliferation of the alveolar epithelium, and in the secondary textural changes which that proliferation after a time originates. Sometimes,

¹ I exclude from this statement minute alveolar caseations, almost always present in the immediate neighbourhood of lymphatic pleural exudations.

when small, the masses are surrounded by fibroid tissue. The cause of their development is difficult to determine; but as far as my own personal observations go, the conditions of their genesis are brought about by the concurrence of gradual thickening or compression of a branch of the pulmonary artery, with obstruction, more or less complete, of the neighbouring lymph-channels.

Concerning the bronchial dilatations and bronchiectatic cavities, it must be observed, in the first place, that, contrary to what might be expected in a greatly contracted lung, they are present only in a small minority of cases. The dilatations are of three kinds: cylindrical, fusiform, and globular. No single hypothesis of their mode of origin, hitherto advanced, seems adequate to account satisfactorily for the whole facts accompanying their development. Sometimes they are present when there is little induration or contraction of lung; and sometimes, when induration and contraction are extreme, they are absent. To traction of the thoracic walls, and of the interbronchial fibroid tissue, as factors in the evolution, must be added the active forces in certain conditions of inspiration and expiration, and degenerative changes in the bronchial walls. In every dilated bronchus, such changes are to be found; and they consist, for the most part, in fatty degeneration of the cartilages, necrotic coagulation of the muscular tissue, and fibroid invasion of the parts below the basement-membrane of the mucosa.

Cavities in connection with dilated bronchi arise, at least, in two ways: from necrotic solution of caseous lumps in the peribronchial areolar tissue or peribronchial alveoli, and from ulcerations of the bronchial mucosa penetrating the alveoli. When formed, these cavities become, of course, subject to the same dilating forces as the bronchi; and not only under the influence of the general respiratory forces, but also under the traction of neighbouring cicatricial bands, they assume the most varied and irregular forms.

Thus altered by the further invasion of the fibroid process and by its secondary effects, the lung, with its consolidations and cavities, its fibrous nodules and caseous lumps, presents the characters of ordinary phthisical disease, and would be commonly regarded as a variety of the tubercular process. And if it be true that the nature of a disease is to be determined, not by its completed history during life, but by the structural changes discovered after death, then it must be confessed that there is much to be said in support of the popular view of the tubercular unity of phthisical disease. And if, still further, we accept without reserve the experiments of Koch and the assertions of his followers, that in every such lung as I have just described, certain bacilli will be found, and that the terms tubercular and bacillary are co-extensive and convertible, then it must be conceded that the debate is closed and the question settled.

But, for my part, supported as these statements are by the most ingeniously devised and carefully executed experiments, I cannot accept them, in the subject under consideration, with unconditional reserve. For, in several cases of phthisical disease following upon fibroid invasion of the lung, I have failed to find the tubercular bacilli in the expectoration or in the lungs. To this it has been replied, that if the investigation had been properly conducted, the bacilli would certainly have been found. The only answer that I can make to such an assertion is this: that the process which fails to reveal veritable bacilli in fibroid, perfectly succeeds in tubercular cases. But assuming, for the sake of argument, that tubercular bacilli are to be found in every ulcerative non-malignant disease of the lung, and that, unlike every other organ in the body, it is insusceptible of any other chronic inflammatory or ulcerative process but the tubercular, our difficulties are not at an end. It is not easy to see how mere differences of constitution and soil can reconcile, with the exclusive action of a single causal agent, the widely differing histories of the affections now grouped under a single species by the bacillary hypothesis. And the difficulty is not entirely met by the reply of chronicity, when we remember how, into whatever texture or organ we pursue it, the structure of the tubercle in acute tuberculosis is always the same. It is quite true that, in the lung, a tubercle when it appears excites fibroid and pneumonic changes, and that one or the other, or both, may so increase as to completely hide the tubercular nodule; it is quite true that sometimes the fibroid and sometimes the pneumonic change predominates; and that, in the latter case, the progress of the pathological changes is speedy, and that in the former it is slow; it is quite true that, in the tubercular nodule, there is a fibrous element, and that sometimes its growth is so disproportionate to the other structural elements that it extinguishes them; and it is quite conceivable, although in over four thousand necropsies I have never seen such an occurrence, that in a veritably tubercular lung one could nowhere find, in its fibroid consolidations, conclusive evidence of the former existence of the tubercular neoplasm. All this is true, or conceivably

true, but it does not refute the observations made by others as well as by me, that inflammatory and non-inflammatory fibroid products may invade, alter, and disintegrate the lung without the presence at any time of either the true tubercular nodule or of the veritable bacillus. To assert that a fibroid pulmonary induration is incapable of ulcerative excavation except through the medium of tubercular bacilli is, to say the least of it, an unproved assumption; and, for the present, at least, has no greater claims to unconditional acceptance than the assertion, made with equal confidence a year or two ago, that the presence of giant-cells in a given growth was conclusive as to its tubercular nature.

Finally, it must not be forgotten that, in accepting the bacillary hypothesis as a dogma no longer to be questioned, we shall have to range under one name diseases which, with apparently nothing in common but the presence of bacilli, are yet, not only in the same body, but even in the same organ, widely different in their symptomatic characters, course, duration, effects, and issues; and that, unless we are to lose some of the most precious parts of our recently acquired knowledge, and to ignore distinctions justly founded on concurrent clinical and pathological observations, we shall have to re-classify bacillary affections in such a manner that, whilst the bacillary supremacy remains acknowledged, the differentia giving them permanent and real, although subordinate, individualities, shall be formulated and maintained.

The homoplastic are not, however, the only changes which occur in the exudations of primitive dry pleuritis. Metaplastic changes arise; and out of the simple structural elements of the proliferative exudation are developed such changes of form and of arrangement as constitute, within certain limits and conditions, fibrous, syphilitic, leprosy, and other growths. But, neither upon them, nor upon the larger considerations which they suggest, have I time at present to dwell. Reviewing the pathological changes brought about by primitive dry pleurisy, it becomes plain that they may be properly arranged, as so many pathological entities, in four divisions: the neoplastic pleuritic membranes, the fibroid lung, the bronchiectatic lung, and the fibroid phthisical lung. The complete and adequate understanding of these pathological changes is undoubtedly important, but it is not sufficient; for, although sometimes they are the direct results of injury coming from without, they are, in the majority of instances, the anatomical renderings or structural expressions of underlying states of system which are of the essence of the disease, and demand the first and chief attention. To these dynamic states we should now, naturally, turn, in order to learn how, by their integrations and disintegrations, their ceaseless groupings and shifting equilibria, they originate, maintain, transfigure, and end the varying structural forms, which are the only visible manifestations of their presence. Such an inquiry, however, would lead us into the realms of speculative pathology, and leave out of sight the clinical uses of our anatomical study. To this humbler task let me proceed; and in trying to show that the pathological entities have corresponding clinical autonomies, let me endeavour to turn the knowledge of this relationship into use for the daily business of our lives.

Before proceeding with this task it may be useful to state, more formally than I have done, the position which, at present, the bacillary hypothesis seems to hold in the scientific mind. In the first place, it is held that there is nothing autogenetically distinctive in the structure or form of a tubercle; that what alone makes a growth tubercular is the presence in it of the tubercular bacillus; that tubercular bacilli are present in all tubercular and scrofulous products, which are thus in nature essentially identical; and that their absence, at some given time, from such growths, is not a proof that the bacilli have never been present, but merely that they have been destroyed by some curative change in the tissues invaded by the parasites.

In the second place, it is held that the inoculation of certain healthy animals with the tubercular bacilli is followed invariably by an eruption of acute general tuberculosis, and that the tubercles thus begotten, as well as their successors for generations, remain inoculable and virulent.

In the third place, it is held that the inoculations of healthy animals with substances not containing tubercular bacilli are invariably infructuous, or fructuous only in products which are either sterile, or beget only local effects.

In the last place, it is held that the true and sole causal agent of tubercular, scrofulous, and allied diseases is the tubercular bacillus; and that the various forms which they assume and the different courses which they follow under the irritative action of the bacilli are accidental results, due to local peculiarities of structure, the influence of external circumstances, and the constitutional tendencies of the invaded organism.

But, whilst some of these contentions are proved, and some are probable, they are neither universally nor unconditionally accepted. There is a minority of persons—and I place myself among them—who contend that the exclusively causal agency of the bacillus, although extremely plausible, is not conclusively proved; that a greater number and variety of control-experiments are yet needed to satisfy a just scepticism; and that, even now, in the affections discussed, there must be admitted the existence of bacillary and of non-bacillary consolidations, and therefore of a bacillary and non-bacillary phthisis (*De la Phthisie Bacillaire*, par le Professor G. Sée, 1884).

At the present time, when men are still in the fervour of their conversion to the brilliant experimental discoveries of Koch, such protestations of a sober judgment will be regarded as unpardonable sins, and punished with suitable severity. Well, the sufferers under chastisement must console themselves with the reflection that it is only those whose judgments have been disturbed by emotion, or who have never sounded the deepest depths of knowledge, or who have not passed through the perils of its subtlest casuistries, that are exempt from difficulties, or doubts, or fears; and that, for the most part, truth is won, not by those who rush impetuously forward in its pursuit, but by those who, with open and eager mind, are yet, in patience, content to "labour and to wait."

THE CROONIAN LECTURES ON THE HYGIENIC AND CLIMATIC TREAT- MENT OF CHRONIC PULMONARY PHTHISIS.

Delivered at the Royal College of Physicians, London, March 1885.

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LECTURE III.

Climates; Purity of Air the most important Element; Floating Matters; Climates of Elevated Regions; Objections Met; General Characters; Physiological and Therapeutical Actions; Swiss Alps; Peruvian Andes; Rocky Mountains; South African Highlands; Home Climates.

v. *Climatic Treatment.*—It is difficult to say anything new on the treatment of phthisis by climate, as the literature on the subject is so rich in good articles. I need only mention the names of Sir James Clark, Walshe, J. E. Pollock, King Chambers, J. H. Bennet, C. J. B. Williams, and C. Theodore Williams, Thorowgood, F. and P. Niemeyer, Rohden, Jaccoud, Biermann, Thilenius, A. H. Hassall, Sée, Symes Thompson, Marcet, Clifford Allbutt, Burney Yeo, Sparks, Denison, Solly, and Tyndale. The remarks which I am going to make can only be very fragmentary.

The difference between different cases of phthisis is so great, that it is impossible to lay down fixed rules for climatic treatment. In deciding between different climates and localities, the circumstances connected with the aetiology, the stage of the disease, the amount of destruction, the complications with diseases of other organs, are very important; but still more so, the distinction between a weak and a strong constitution, an excitable or a torpid nature, between progressive and retrogressive, active or stationary cases. Mental peculiarities, too, ought not to be overlooked—the habits of the invalid, the circumstances in which he has lived. Unlike, however, as different invalids are in these and other points, in all of them we must bear in mind that we have to deal with raw and ulcerated surfaces in the respiratory passages, surfaces which, in most cases at all events, are infected by a specific microbe, and are very susceptible to all impurities of the atmosphere, and especially to the microbe-element which abounds wherever organic decomposition, and especially putrefaction, takes place, and wherever there are congregations of human beings and animals in shut up localities; hence it is clear that purity, or an aseptic state of the air, is the first demand which we ought to make on the climates to which we send persons affected with phthisis. Temperature, the degree of moisture, atmospheric pressure, light and

sunshine, electricity, wind, frequency or absence of rain and snow, nature of soil, elevation above the plain or the sea, which, in their varying combinations, form the different climates, are each and all important agents in the climatic treatment, as we have endeavoured to show elsewhere; but none is so essential to the consumptive patient as the purity of the atmosphere. After what we have said before on the necessity of pure air, and its renewal in rooms, it is scarcely necessary to add here that, in every climate, the position and the internal arrangements of the house, and particularly of the rooms in which the invalid is to live, are as important as the character of the climate of the place.

In former years, the composition of the air in its influence on health was judged principally by the amount of oxygen, nitrogen, carbonic acid, ammonia, and water; but, of late, attention has been forcibly directed to the amount of *floating matter* in the air by Ehrenberg, Pasteur, Tyndall, Maddox, and others; and a great accession to our knowledge, and a fuller appreciation of the influence of the atmosphere, has been obtained by the labours of Miquel at the Observatoire de Montsouris, near Paris, to which Professor Sée has directed my attention, and the result of which has been mentioned by Dr. Poore in his Cantor lectures already alluded to.

Miquel gives us the following interesting table of the number of bacteria found in ten cubic metres of air, taken as nearly as possible at the same time in July, 1883:—

	Bacteria per 10 Cubic Metres.
1. At an elevation of from 2,000 to 4,000 metres ...	None
2. On the Lake of Thun (560 metres)	8.0
3. Near the Hotel Bellevue (Thun, 560 metres) ...	25.0
4. In a room of the Hotel Bellevue.....	600.0
5. In the Park of Montsouris, near Paris	7,600.0
6. In Paris itself (Rue de Rivoli)	55,000.0

This table shows clearly, as we have already pointed out, the difference between a high and low elevation, and between town and suburb; and also between indoor and outdoor air, the air in a room of the Hotel Bellevue, containing twenty-four times as many microbes as the air on the grounds outside. The difference between the air on the lake of Thun=8.0, and on the shore, that is, the grounds of the Hotel Bellevue=25.0, is likewise significant; and the low rate on the former may be ascribed to the distance from the sources of organic decomposition. We may reasonably infer that a still greater rarity of microbes will be found in the air on high sea. Similar researches into the purity of the air are being energetically pursued at Berlin, but I am not yet acquainted with the result.

Another point of consideration is: How far do climates and health-resorts assist the invalid in improving the general nutrition and power of resistance? This depends to a great degree on their enabling the invalid to be much in the open air, and take active exercise without risk of chills and consequent complications. Not all the climates, however, which allow the invalid to be much in the open air, are at the same time conducive to active exercise. Some are apt to produce a feeling of languor and diminished inclination for food, while others raise the nervous system, accelerate and improve the appetite, digestion, sanguification, and muscular energy, and facilitate the elimination of used up matter. We may, in some points, compare climates with medicines. There are such medicines as morphia, which soothe the cough and procure sleep, but check the appetite and nutrition in many people; antipyrin has a wonderful power in subduing pyrexia, but, in almost all my trials of its effect on consumptive patients, it has entirely suppressed the appetite. Such medicines ought, therefore, to be avoided in the majority of hopeful cases of phthisis, because the improvement of the nutrition is the first demand; so there are agreeable climates which soothe the cough, but diminish the appetite, and the inclination to take exercise, and can, therefore, be recommended only in exceptional cases. On the other hand, bitter remedies and tonics do not soothe the cough, but if they improve the appetite they often exercise a beneficial influence on the course of phthisis. In the same way, cold does not soothe the cough, but, on the contrary, sometimes produces it at first; but, if it improve the appetite of the consumptive person, and enable him to take more exercise, it improves the nutrition, and thus exercises a beneficial influence on the course of phthisis. The consideration of such qualities of climate is all-important in the treatment of phthisis, though these characters are not shown by meteorological tables, however carefully prepared; they must be learned from personal observation, and from carefully watching invalids and their healthy companions. In these points lies the difference between what are popularly called relaxing and bracing climates. We will not, however, disregard meteorological tables and descriptions, for from these we often learn important facts about the nature and strength of wind, the frequency of mist and rain, the conditions of tempera-