domen except, perhaps, that it is somewhat fuller than usual along the median line. There is no tenderness and no tympany or dullness anywhere. Color of skin normal. The bowels move without pain; are seldom constipated; urine normal; and the child has grown an inch and a half in height, and has gained nearly ten pounds in weight in about three months.

THE PATHOLOGY OF BRONCHO-PNEUMONIA.¹

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I SHALL offer for your consideration, this evening, some observations on the subject of broncho-pneumonia. I venture to do this for the reason that I believe that this particular lesion suffers from the effects of tradition, from having been called catarrhal pneumonia, and from its relations to pulmonary phthisis. It is also doubtful whether the profession appreciate what a common lesion it is.

I do not mean that the real lesions and symptoms of the disease have not been described. They have been described by different observers; but their descriptions have been, for the most part, fragmentary, and have failed to give a picture of the disease.

The current notions concerning the disease have remained somewhat obscure and indefinite. The prevailing ideas concerning broncho-pneumonia may be stated as follows:—

That the terms broncho-pneumonia, lobular pneumonia, catarrhal pneumonia, and capillary bronchitis may all be used to designate the same lesion: although it is customary to use the words broncho-pneumonia and lobular pneumonia when the disease occurs in children; capillary bronchitis when it occurs in adults; and catarrhal pneumonia when it is believed to be a form of phthisis.

That the inflammation begins in the bronchi, extends to the small and capillary tubes, and then to the groups of air vesicles which belong to these bronchi, and that for this reason the hepatization assumes a lobular form.

That obstruction of the bronchi with inflammatory products frequently produces areas of atelectasis.

That the catarrh may become chronic, the products of inflammation in the air vesicles undergo cheesy degeneration, interstitial changes be developed in the frame-work of the lung and so a form of pulmonary phthisis be produced.

This, I think, is a fair enough example of the ordinary accounts of broncho-pneumonia — accounts which fail to bring out the essential features of the disease.

Let us, then, turn to the conditions themselves — to the clinical symptoms and the lesions of broncho-pneumonia as we all can see them for ourselves.

To approach the subject properly, we must consider the symptoms and lesions of acute bronchitis as well as those of broncho-pneumonia.

First, then, of *acute catarrhal bronchitis*. This is a disease of very common occurrence, especially in children, but one which seldom proves fatal. Our knowledge of its lesions is derived from exceptionally severe

cases, from cases which are complicated by other diseases, and from the symptoms which we observe during life.

The inflammation involves regularly the trachea and the larger bronchi; less frequently the smaller bronchi also. As a rule the bronchi in both lungs are equally affected.

The first change seems to consist in a congestion and swelling of the mucous membrane of the bronchi with an arrest of the functions of their mucous glands. This is attended with pain over the chest, a feeling of oppression, rapid or asthmatic breathing, and a dry cough.

Fever and prostration are present in a degree corresponding to the extent and severity of the inflammation and to the age of the patient.

After this the mucous glands resume their functions with increased activity, the congestion and swelling diminish, there is a more rapid desquamation of the superficial epithelial cells, an increased growth of the deeper epithelial cells, and a moderate emigration of white blood cells. Sometimes the red blood cells also escape from the vessels.

The patient now has less pain and oppression, the cough is accompanied with an expectoration of mucus, mixed with epithelium, pus, and sometimes blood. After death the only lesions visible are the increased quantity of mucus, the growth of new epithelium, a few pus cells infiltrating the stroma of the mucous membrane, and sometimes a general congestion. If the smaller bronchi are involved they contain pus cells.

In a moderate number of cases, especially in very young children, certain accessory lesions are added. There may be a general congestion of the parenchyma of the lung, and even a filling of some of the air vesicles with inflammatory products. Still further, the filling of the small bronchi may lead to the collapse of the groups of air vesicles to which they lead, and thus are produced areas of atelectasis, which may be further changed by inflammatory processes.

In acute catarrhal bronchitis, then, the inflammation involves regularly only the mucous membrane of the bronchi; and in this mucous membrane the only changes are: congestion, swelling, changes in the epithelial cells, and in the functions of the mucous glands.

As complicating conditions, we may find atelectasis, congestion of the parenchyma, and areas of diffuse pneumonia.

Now let us consider the lesions and symptoms of broncho-pneumonia.

This disease is of common occurrence in children as an idiopathic inflammation, and as a complication of measles, whooping-cough, scarlet fever, and diphtheria. In adults it occurs less frequently, but in them also it may be idiopathic, may complicate the infectious diseases, and may follow injuries of the brain and spinal cord. Constitutional syphilis also may give rise to broncho-pneumonia, and in pulmonary phthisis this same inflammation constitutes an important part of the lesions.

In children, while the inflammation always presents the same essential characters, yet there is considerable diversity, both in the symptoms and in the lesions, in different cases. Thus, in infants a few weeks old, often the only symptoms are rapid breathing, a febrile movement, prostration, and death.

In older children there are well-marked constitu-

¹ Read before the Pathological Society of Philadelphia, October 23, 1884.

tional disturbances — fever, prostration, and cerebral symptoms; in some cases the cerebral symptoms being excessively developed. The breathing is rapid. There may be cough. The physical signs are those of bronchitis alone, or of bronchitis with consolidation of the lung. If there is consolidation it is developed slowly, and disappears slowly. Not infrequently successive portions of the lung become consolidated. The disease terminates in the death of the patient, in recovery, or it assumes a chronic character. This disposition of the broncho-pneumonia to become chronic is one of its characteristic features, a feature in which it differs from acute bronchitis and lobar pneumonia. The cases vary, however, as to the degree in which the disposition is carried out.

In some children the disease after running its regular course of one or two weeks subsides, the constitutional symptoms are less marked, the child seems better in every way. But yet the physical signs of consolidation continue, there is still a slight rise of temperature, and convalescence does not fairly begin. In this condition the child may remain for a number of weeks and then get entirely well, except that the percussion note and the breathing remain somewhat changed.

In many such cases as these the recovery is permanent and the child has no further trouble. But in other cases, after the lapse of several months, the child is attacked with acute general tuberculosis. Thus it is not uncommon in children's asylums for an epidemic of measles complicated with broncho-pneumonia to be followed after the lapse of a year by an epidemic of acute tuberculosis.

In other children the course of the disease is more protracted. The physical signs of consolidation continue, there is a febrile movement, the child has no appetite, it gradually emaciates, and dies at the end of several months. These cases resemble pulmonary phthisis in their symptoms, but they are really only examples of a broncho-pneumonia which has become chronic.

In still other children the physical signs and the constitutional disturbances continue, but the child does not succumb to the disease. It continues to live with the evidences of a chronic bronchitis which go on year after year. So the child may grow up to adult life, sometimes better, sometimes worse, never entirely well. Cough, expectoration, dyspnoea, occasional fever harass the patient at intervals. The lung becomes more and more solid, the bronchi more dilated, the pleura thicker, and the affected side of the chest more retracted.

In the cases of acute broncho-pneumonia which die within from two days to three weeks there is some variety in the *post-mortem appearances*.

The lungs may be large and well aerated, but on section the cut ends of the medium-sized and smaller bronchi are unusually prominent and thick, and around them are little zones of hepatization of red, or gray, or white color. This appearance of the lung may be further modified by a cylindrical dilatation of the thickened bronchi.

In other cases the lungs are denser and more congested, and a larger or smaller portion of them is consolidated. The consolidation portions are unaerated, dense, and smooth, of red color, or pinkish gray, or dark red. Or the color may be mottled, — small, rounded gray or whitish areas surrounded by red hepatization.

The distribution and extent of the consolidation also

vary. The hepatized areas may be small, encircling the bronchi, and situated at some distance from each other. Or they may in some one lobe or part of a lobe be close together, and between them is a more diffuse hepatization so that this part of the lung may be completely solid.

The appearance of the consolidated lung may be further changed by a cylindrical dilatation of the bronchi.

In still other cases the consolidated portions of lung are of some size and of somewhat regular shape, as if they were portions of lung corresponding to bronchi. These portions are dense, unaerated, of dark-red color, and somewhat shrunken.

If the inflammation has become chronic, then over one lobe or part of a lobe the pleura is thickened, bands of fibrous tissue run into the substance of the lung, and the lung tissue is dense, hard, and unaerated.

When we examine these lungs more minutely we notice first some peculiarities which belong to them because they are the lungs of children and not of adults. The bronchi and the connective tissue framework of the lungs occupy a larger relative space than they do in the lungs of adults; and in any inflammation of the lungs they are apt to take a more prominent share. The air vesicles are small, and products of inflammation which have been formed within them are absorbed slowly and with difficulty. The walls of the vesicles are lined with a nearly continuous layer of epithelial cells. When the vesicles are inflamed there is a greater production of new epithelium and a less of fibrine than in adult lungs. The small size of the air vesicles render a simple congestion and dilatation of the capillary vessels within their walls a more serious condition than it is in adults. The bronchial glands are more regularly and intensely inflamed. These peculiarities of the child's lung seem to account for its liability to certain forms of inflammation.

The same exciting causes apparently produce in a child under five years of age broncho-pneumonia; in a person between the age of five and fifteen broncho-pneumonia or lobar pneumonia; in an adult lobar pneumonia.

Now let us consider more in detail the lesions of broncho-pneumonia in children.

The trachea and large bronchi are congested and coated with mucus, as in acute bronchitis; but in the smaller, and to a less extent in the capillary bronchi, the changes are of a different character. In these small bronchi the entire thickness of their walls is infiltrated with cells, — partly new connective tissue cells, partly pus cells. This change may affect the small bronchi equally in all parts of the lungs, or it may be confined to those situated in one lobe or part of a lobe.

Around every bronchus, of which the walls are infiltrated with cells in this way, is a zone, either of intense congestion or of pneumonia, the inflammation extending directly outwards from the bronchus to the surrounding vesicles.

In the zones of peribronchitic pneumonia the walls of the air vesicles are infiltrated with cells in the same way as are those of the bronchi. The cavities of the vesicles are filled with pus and epithelium, or with an organized tissue composed of a basement substance and cells.

These constitute the essential features of the lesion,

— a bronchitis which involves the *walls* of the bronchi, and a pneumonia which involves the vesicles *surrounding* the bronchi, and which produces changes in the *walls* of the vesicles as well as in their cavities, while the inflammatory products within the cavities of the vesicles are not only pus and fibrine, but also organized tissue.

To these essential lesions are often added other accessory changes. The bronchi, of which the walls are infiltrated with cells, may be dilated. Between the zones of peribronchitic pneumonia the lung is congested, and there may be areas of diffuse red hepatization, which do not, however, correspond to bronchi. There is often a layer of fibrine on the pulmonary pleura. There may be areas of atelectasis corresponding to obstructed bronchi.

The bronchial glands are swollen, and the seat either of simple or of tubercular inflammation.

When the broncho-pneumonia passes into the chronic condition the inflammation usually persists only in part of a lobe, or a single lobe, while the rest of the lungs return to a normal condition. In that portion of the lung in which the inflammation persists we find the small bronchi with their thickened walls and their zones of peribronchitic pneumonia. The number of bronchi involved may be moderate, and then a section of the lung will look as if it were studded with fibrous nodules. Or most of the bronchi may be involved, the zones of peribronchitic pneumonia are close together, and the entire lung tissue is dense and solid. In either case the bronchi may be dilated and the pulmonary pleura thickened. As the inflammation goes on its interstitial character becomes more and more marked, until the affected portion of lung becomes converted into a mass of fibrous tissue, in which the bronchi still remain, while the air vesicles are obliterated. The blood-vessels, however, are for the most part not obliterated, so that the lung does not become necrotic or degenerated. Still occasionally areas of cheesy degeneration exist.

These are the characteristic features, then, of the broncho-pneumonia of children.

In *adults* broncho-pneumonia occurs in one of four forms: As an idiopathic inflammation of acute and severe type. As a subacute inflammation. As a complication of the infectious diseases and of lesions of the brain and spinal cord. As one of the lesions of phthisis.

(1.) *The acute, idiopathic broncho-pneumonia of adults.*

The invasion of this disease is acute and severe.

The patients have rigors; pains in the head, back, and chest; vomiting and marked prostration. The temperature runs between 102° F. and 105° F.; the pulse is rapid; the breathing is rapid and unsatisfactory. There is cough, at first dry, later accompanied by profuse muco-purulent and bloody expectoration. There is venous congestion of the skin, albumen in the urine, and cerebral symptoms. When we examine the chest we find the percussion note normal, or exaggerated, or dull. There are crepitant, subcrepitant, and coarse râles with sibilant and sonorous breathing.

The cases usually terminate fatally in about seven days. After death we find both lungs large, heavy, and congested. There is fibrine on the pulmonary pleura. The trachea and large bronchi are congested and coated with mucus. The smaller bronchi contain pus, their walls are thickened and infiltrated with cells,

and around them are zones of air vesicles with their blood-vessels gorged with blood, and in their cavities epithelium pus and fibrin.

(2.) *The subacute broncho-pneumonia of adults.* This is a rare disease. It has a clinical history much resembling that of acute phthisis.

The patients are attacked with prostration, fever, cough, and muco-purulent expectoration, dyspnoea, pain in the chest, coarse râles all over the chest, with dullness over the consolidated portion of the lung. These symptoms continue, the patients lose flesh and strength, and die at the end of several weeks.

After death we find fibrine on the pulmonary pleura. The larger bronchi are congested and coated with mucus. There is an irregular, diffuse red hepatization mottled with small white nodules from the size of a pin's head to that of a pea. In the diffuse red hepatization the air vesicles are filled with pus, epithelium, and fibrine. The white nodules correspond to sections of bronchi with zones of peribronchitic pneumonia. These bronchi are of small size, they contain pus, their walls are thickened and infiltrated with cells, and they may be dilated.

In the peribronchitic zones of pneumonia the walls of the vesicles are thickened and infiltrated with cells, but the blood-vessels remain pervious and can be injected. The cavities of the vesicles are filled not with pus and fibrine alone, but also with a basement substance of homogeneous or finely fibrillated character, in which are imbedded polygonal, round, and fusiform cells.

(3.) *The complicating broncho-pneumonia of adults.* It is not uncommon for some of the infectious diseases, and some of the lesions of the brain and spinal cord to be accompanied by the development of this form of inflammation of the lung.

In typhoid fever we sometimes find a broncho-pneumonia exactly resembling the same lesion as it ordinarily occurs in children.

In pyæmia the inflammation is of the same kind, but is apt to be less extensive, involving only part of one or both lungs.

With lesions of the brain and spinal cord the changes are the same as with pyæmia.

(4.) *With phthisis*, both acute and chronic, broncho-pneumonia often forms an important part of the morbid changes in the lungs, but yet it is never the primary or the only lesion. It is only one of a number of pathological changes which go to make up the complex whole of pulmonary phthisis.

From what has been said, then, I would draw the following conclusions:—

There is a form of inflammation of the lung which may properly be called broncho-pneumonia.

In children it is the most frequent form of pneumonia, in adults it is less common.

It differs from bronchitis and from lobar pneumonia in that the inflammation effects changes in the *walls* of the bronchi and of the air vesicles, and this peculiar interstitial character of the process exists from the very outset.

The inflammation extends from the bronchi, not to the group of air vesicles into which they lead, but directly outwards to the vesicles which surround the inflamed bronchi, and in these vesicles the walls are changed.

The interstitial character of the inflammation is its most important feature. It accounts for the severity

of the symptoms, the frequent long continuance of the consolidation, the dilatation of the bronchi, and for the tendency of the broncho-pneumonia to assume a chronic character.

The complicating tubercular inflammation of the bronchial glands may give rise later to general tuberculosis.

Broncho-pneumonia is not a form of phthisis; it is doubtful if it is ever directly followed by phthisis; but it constitutes a part, and often an important one, of the lesions which constitute phthisis.

I have endeavored to describe in a somewhat incomplete way the characteristic symptoms and lesions of an ordinary disease. I am well aware that I have described conditions which are familiar, and that nothing which I have said has not been said before.

But the very common occurrence of this form of inflammation of the lung renders it all the more important. The varying character of the lesions has confused their essential and their accidental characters, and I think it is worthy of consideration whether the views which I have advanced concerning the pathology of the disease are not the true ones, namely, that the inflammation is essentially and from the outset an interstitial one, more or less complicated by other conditions.

RECENT PROGRESS IN PATHOLOGY AND PATHOLOGICAL ANATOMY.

BY WILLIAM F. WHITNEY, M. D.

ENKATARRHAPHIA OF EPITHELIUM.

THE artificial production of tumors in animals has often been attempted in the hope of discovering the laws governing their development in man. Thus far but little success has been obtained, especially in the production of a new and atypical growth of epithelium. The experiment has usually been based upon the transplantation of a portion of tissue directly from one spot to another. Kaufmann¹ has varied this by leaving the skin in connection with its own subcutaneous tissue, but at the same time surrounding it by connective tissue. This is easily accomplished as follows: A small oval cut (five to ten mm. long by two to four mm. wide) is made through the epidermis, and the adjacent edges loosened. These are then raised over the included bit and united by fine sutures. In very thick skin they must be undermined for a short distance, in order that they may be joined over the sunken portion without tearing. If the wound heals by first intention there is an epithelial layer nourished from its own base and touched on all sides by fibrous tissue.

In hairy animals this succeeded with difficulty, as although the wounds readily closed they rarely remained so for any length of time. It was then suggested to operate upon the combs and wattles of fowls, which are absolutely hairless and without glands of any sort. Several places could be used at the same time upon the same bird, and could be cut out for examination whenever wanted. In this way the process was followed to the two hundred and tenth day.

In the successful cases the result was constant. The epithelium never disappeared, but continued to grow.

In the earliest days it remained flat, and covered the underlying tissue, which was rich in engorged blood-

vessels, and only sparsely infiltrated with cells. No strain was exerted upon the inclosed piece, as there was no tendency of the edge to bend up. In a few days more, however, the epithelial line began to assume a bowed shape, due to an increased width, as shown by careful measurements. It continued to grow in this direction until the upturned edges met, and there was thus formed a little cavity lined with epithelial cells. A peculiar fact was noticed, namely, that this new-formed layer exceeded the old in thickness, and that desquamation was more abundant from the upper (new) layer than from the lower (original) layer. In no case was there ever the faintest trace of growth downward into the corium, either in the form of tongue-shaped projections or nests of isolated cells. With this formation of a wen the end was reached. At the close of the seventh month the cavity was no larger than in the third week.

In the surrounding tissue the cellular infiltration and hyperæmia gradually subsided. The connective tissue became firmer, its fibres and vessels took the regular direction of the fixed corium, from which, finally, it could not be distinguished. If this was all that happened the matter should be left here, but there was an unexpected occurrence which is of importance, and not so easily explained.

In preparations made from specimens of the second or third week there were found groups of large cells scattered throughout the cicatricial tissue or in the immediate vicinity. These were composed of a delicate protoplasm, without marked differentiation of their contour, with large numbers of nuclei, which were in part regularly and in part irregularly arranged. In the elongated cells they lay parallel with the long axis, while in the rounder cells they were parallel among themselves. Such must evidently be giant cells. Here and there they were packed in alveoli, and closely resembled epithelium. Careful histological examination failed to reveal any normal glandular elements that could give rise to them. At first, therefore, the idea was entertained that they arose from epidermis cells which had been loosened and scattered by the operation, and having found a suitable place in the tissue had grown into giant cells. Still they were always found at some distance from the inclosed skin, and separated from it by connective tissue. Moreover, no intermediate stages were ever seen. Giant cells have been found in the vicinity of freshly-healed wounds, and it might be supposed that these were the results of the irritation of the operation. Their life history at once removed them from this class, as they persistently increased in size and number, while those which occur in the process of cicatrization disappeared with its completion.

In the case under observation tumors as large as a bean were formed, and this size was attained about the one hundred and thirtieth day. After that they ceased to grow, but there was no indication of retrograde metamorphosis. From the presence of a little cleft in the middle of one of these clumps, and from the arrangement and shape of the surrounding nuclei, it was probable that they were formed in preëxisting spaces, which were most likely to be lymph vessels, these having been obliterated by an organization of a thrombus.

The results of the experiments are formulated as follows:—

An atheromatous cyst was formed by the development of the skin which had been buried, — a true epi-

¹ Virchow's Archiv, vol. xcvii, p. 236.