collapsed parts contain more blood and serum, and hence there is a marked difference in appearance of the affected and surrounding surfaces, since the latter are distended with air, and paler; are, in fact, in the condition of vicarious emphysema. The pleura is usually normal; it may be somewhat congested and thickened. The situation of the collapsed lobules is due to the position of the compressing force. If the force of the compression has not been sufficient to drive all the blood and air out, it is then said to be *carnified*; if all blood and air are excluded, the color is grayish, and the texture is firm.

Symptoms.—In congenital atelectasis, symptoms are produced only in the event that a considerable number of lobules are collapsed, when the chief sign is imperfect respiration. The thorax has but little amplitude of movement, the breathing is rapid but superficial, and the voice is nothing more than a husky whisper. So rapid is the breathing, and urgent the need of air, that a child so affected nurses with difficulty, or not at all. The supply of oxygen being inadequate, carbonic acid accumulates; the lips are blue, the extremities blue and cold, and very feeble, and there are drowsiness, muscular twitchings, and possibly convulsions and paralysis. In the acquired form, the collapse of the lobules is preceded by bronchitis of the finer tubes. When the atelectasis occurs, the difficulty of breathing increases, there is corresponding frequency, and the movements of the two sides may be unequal if there be a limitation to one lung. In inspiration, instead of expansion of the chest in all directions, there is retraction of the intercostal spaces, and of the inferior ribs, due to the fact that the lungs can not be expanded. The significance of the physical signs will depend on the extent to which the atelectasis has proceeded. If isolated lobules only collapse here and there, and the adjacent lobules are dilated (vicarious emphysema), there will be no appreciable change in the sonority. If, however, a group may be collapsed of considerable extent, there will be dullness, but the note will have somewhat the tympanitic quality. The changes on auscultation will depend equally on the amount of tissue in the condition of collapse. The respiratory murmur will be replaced by bronchial sounds if there are a large number of lobules atelectatic. These sounds will also change with the alterations in the affected parts—an increase of the collapse will enlarge the area of dullness; improvement in the local condition and the reëntrance of air will reproduce the vesicular murmur. As very pronounced lesions are associated with the atelectasis, obviously the symptomatology will be very much influenced by them. An important complication arises from the collapse of lobules: the pulmonary circulation is obstructed, the blood accumulates on the right side, the cavities dilate, the venous system is abnormally full, and the arterial system is ischæmic. The results of this state of things are, therefore venous stasis and œdema, the pulse is small, the urine scanty and high-colored, and the skin pale and relaxed.

Course, Duration, and Termination.—The course of atelectasis is that of the malady associated with it. The congenital form, if limited in extent and not associated with a patulous condition of the foramen ovale, may get well. If, however, it is extensive, and especially if the cardiac anomaly exist, life will continue feebly for a short period, and death occur, frequently in convulsions. The acquired condition, when associated with capillary bronchitis and catarrhal pneumonia, pursues two directions: imperfect recovery with damaged lungs, these organs becoming emphysematous; caseous pneumonia and phthisis. The duration, therefore, becomes indefinite, and the termination that of the associated disease. Acute cases terminating fatally rarely continue longer than one week.

Diagnosis.—Atelectasis is to be distinguished from bronchitis, pneumonia, and effusions in the thorax. As atelectasis is usually associated with bronchitis, the distinction will rest on the evidences of consolidation of the lung, which are not present in bronchitis. There are no real differences between atelectasis and catarrhal pneumonia, since atelectasis occurs more or less in the former; hence the distinction must rest on the course and behavior, on the locality, and the difficulty of breathing with retraction of the ribs, which occurs in atelectasis and not in catarrhal pneumonia. From croupous pneumonia atelectasis is distinguished by these symptoms, which are peculiar to pneumonia: localized pain, initial chill, high temperature, crepitant *râles*, crisis—and do not occur in atelectasis.

Treatment.—In the congenital disease, the child should be made to cry vigorously, or the lungs should be well expanded by an efficient and careful inflation with condensed air—an ordinary fire bellows will suffice. The chest should be irritated with mustard and tincture of iodine, the great delicacy of an infant's skin being regarded. Respiratory stimulants are very useful. Belladonna stands first, next strychnia. Suitable nourishment must be given, and stimulants should also be freely but carefully administered. In the treatment of the acquired disease, the accompanying bronchitis is the point to which attention must be directed. The author has witnessed such important results from the use of iodide and carbonate of ammonium, that he must repeat his recommendation of them. They should be given in small doses frequently repeated. By increasing the flow of serum and lessening the viscidity of the tough secretion which occludes the terminal bronchi, the access of air is again secured to the alveoli. Stimulants to the respiratory function are equally necessary as in the congenital form. Belladonna, or, preferably, atropia ($\frac{1}{200}$ grain *ter in die*), turpentine, eucalyptol, copaiba, are very valuable remedies for this purpose. If the symptoms are urgent, emetics must be used to

clear the tubes, of which the most effective are apomorphine, subsulphate of mercury, and ipecac. If the strength is reduced, or if the disorder has occurred in a strumous or rachitic subject, quinine, arsenic, iron (syrup. ferri iodidi, ʒ j *ter in die*), and cod-liver oil, are very necessary and useful. Inhalations of compressed air should be practiced as soon as the condition of the patient will warrant it. Inhalations of turpentine-fumes, and of the vapor of iodine or ethyl iodide, are very efficient in removing lingering bronchial lesions.

EMPHYSEMA OF THE LUNGS.

Definition.—As *emphysema* means an infiltration of the connective tissue with air, certain adjectives are necessary to define the position. Pulmonary emphysema is the form of disease meant here. A general emphysema of the connective tissue of the body is produced when a fractured rib, puncturing the lung, permits the air to pass through the injured pleura into the connective tissue. The subject of pulmonary emphysema has been much confused by the variety of terms employed in explanation of the characteristics of the disease. There are two varieties, as regards the part of the lung affected : the *vesicular* and the *interlobular ;* the former meaning *alveolar emphysema*, the latter meaning the presence of air in the space between the lobules of the lungs and underneath the pulmonary pleura, whence the terms *interlobular emphysema*, *sub-pleural emphysema.* When the disease occurs as an idiopathic and independent malady, it is known as *substantive emphysema ;* when developed because of another malady, as, for example, the dilatation of the alveoli which occurs because of atelectasis, it is known as *vicarious emphysema.*

Causes.—There is a type of lung, transmitted by heredity, which is peculiarly liable to emphysema. The alveoli are relatively too large and their walls thin ; the connective tissue too largely developed ; the vascular supply is insufficient ; the chest is deep, and the heart lies lower than is normal ; and the muscles of respiration are thin and rather weak. Males are more liable than females, because more exposed to the conditions exciting the malady. It is said, but this statement must be regarded as doubtful, that musicians blowing wind-instruments are apt to suffer from it. Various injuries and diseases of the chest which limit the movements of the lungs, as curvature of the spine, pleural adhesions, hydrothorax, tumors, etc., are supposed to produce it. Vicarious emphysema is especially due to attacks of capillary bronchitis and atelectasis in youth and early manhood, or succeeds to whooping-cough and measles for the same reason that bronchitis has led to collapse of lobules, and consequent emphysema of those not collapsed. All of the causes and conditions producing capillary bronchitis are therefore concerned in the production of emphysema. Interlobular and sub-pleural emphysema are caused by rupture of acini, usually by such mechanical violence as severe coughing, but there is necessary to this result probably a weakness of the part yielding to such force. Various theories have been proposed to account for the production of emphysema : they may be referred to two groups — inspiratory and expiratory. As, however, original faulty structure may exist, emphysema is produced in such by causes which would not affect healthy lungs. This form or type of structure, which is distinctly hereditary, has been referred to above. In addition to these changes, Freund explains the production of emphysema by a theory which supposes the thorax to be in a condition of fixed dilatation by alterations in the costal cartilages. Although this state of the thorax may sometimes be a cause of emphysema, it can not be so frequently. That the original faulty structure is an important factor in the production of emphysema is certainly true ; but that the respiratory acts of inspiration and expiration have also much influence can not be doubted. A certion proportion of cases of vicarious emphysema are explained by Williams's theory of *negative inspiratory pressure ;* that is, the alveoli appended to unobstructed bronchi dilate in consequence of the increased pressure due to the obstruction and disuse of many tubes. If there exist an hereditary change in the structure of the alveoli, this increased pressure causes them to yield permanently and lose their elasticity. If the inspiratory pressure is thus increased, i. e., by the obstruction to many bronchi throwing a larger volume of air and higher pressure on those admitting air freely, and the expiratory pressure is lessened, there will occur emphysema by atrophy of the alveolar tissue—the theory of Niemeyer. A large proportion of cases are produced undoubtedly by *forced expiration.* In the act of coughing, the glottis being closed, the expiratory pressure is certainly very great, and all the more in the unobstructed lobules, because so many are closed and are in the atelectatic state, throwing the whole force of expiration on a less number of lobules. The result is that the alveoli yield in those parts of the chest not protected by bony walls, at the apex, and toward the root, at the anterior border, in those situations where the emphysematous condition is most decided.

Pathological Anatomy.—Enlargement of the lungs is not always found as expected ; adhesions may prevent the anterior borders coming forward to the median line, or the lungs may be actually smaller than normal by the collapse of many lobules, the occurrence of interstitial pneumonia, and the contraction of the connective tissue. On the other hand, the lungs may fill up the thorax, cover the præcordial space, depress the heart, and lengthen the thorax to the seventh rib by depression of the diaphragm. When the emphysematous lungs are removed from the thorax they do not collapse, and remain full, especially if the bronchi are swollen and filled with viscid mucus,

which will prevent the egress of air. The situation of the emphysematous portions will depend on the form. In those cases due to heightened expiratory pressure, the force is expended on the apex and anterior border, and hence here will be found the characteristic changes. In vicarious emphysema, due especially to broncho-pneumonia, the altered portions will exist more widely—at the apex, the anterior border, and along the diaphragm, or they may be very irregularly distributed about the atelectatic points. The appearance of a lung affected with emphysema is peculiar: it is of a pale-red color, the enlarged lobules are little sacs or bladders, not larger than from the size of a pin's-head up to that of a pea, but by the breaking down of the septa between them a number may coalesce, forming a bladder the size of a walnut. When pressure is made, the elasticity of the lung is found to be so much impaired that the pits made disappear slowly or not at all. The tissue of the lung is also very dry and anæmic, and but little fluid of any kind exudes from it on section; but there is much pigment deposited in small, localized collections, and traversing the atrophied tissue in lines, the remains of blood-vessels. On microscopical examination, the walls of the acini are found to be exceedingly thin and attenuated, the septa broken down so that the remains of them merely project into the infundibular area, or disappear entirely.* In some specimens, the intervening connective tissue becomes hypertrophied, so that the walls of the vesicles appear much thickened. In the progress of the atrophic change, the septa between the lobules breaking down, a number of acini are thus converted into a large one. The blood-vessels are from the beginning obstructed, the red corpuscles pass out by diapedesis, and, collected in groups, form the masses of pigment already mentioned, or the blood-globules retained by the arrest of the current and obliteration of the vessels in front form a fine tracery of pigment. The continued pressure sets up a rapid degeneration of the vessel-walls, and they ultimately disappear by absorption, whence it happens that the tissue is dry and bloodless. The obstruction to the pulmonary circulation is ultimately so great that the pulmonary artery and right cavities become greatly distended. Finally, the muscular tissue of the heart undergoes degeneration, granular and fatty. The distention of the veins leads to widespread venous stasis—nutmeg-liver, congested kidneys, and albuminuria, gastro-intestinal hyperæmia and catarrh, passive congestion of the brain, etc.

Symptoms.—The usual history of cases of emphysema is the occurrence of attacks of capillary bronchitis, catarrhal pneumonia, or at least of severe bronchitis at some period in childhood, after which there exists a great susceptibility to colds and frequent attacks of

* Thierfelder, "Pathologische Histologie," 1. Lieferung, Tafel vi.

severe catarrh with difficulty of breathing. After puberty the difficulty of breathing is found to be more decided; bronchial catarrh is not then a matter of cold weather and attacks of acute cold, but is constantly present. In other cases, after whooping-cough, or measles, a troublesome cough, bronchial catarrh, and shortness of breath come on, and steadily increase. If such attacks have occurred in youth, by the time of puberty the emphysema is pronounced, and the chest has assumed the peculiar "barrel-shape," characteristic of this disease. In still another group of cases, the onset is gradual, and the emphysema is the outgrowth of years of bronchial catarrh, the fully developed emphysema not being attained until the middle or after period of life. In which mode soever emphysema manifests itself, the difficulty of breathing is the most pronounced symptom. In all attempts at active exercise, mounting stairways, ascending heights, etc., the breathing is embarrassed. Even before the patient is conscious of his pulmonary defects in this direction, a good observer will note the frequency and imperfect expansion of the thorax. The shortness of breathing is dependent on several factors: the diminution in the number of capillaries has an effect in this way by the lessening, which the loss of vessels involves, of the oxygenation of the blood, so that increasing frequency of respiration is compensatory of this deficiency. Again, depression of the diaphragm renders additional efforts on the part of the inspiratory muscles necessary, and hence this adds to the difficulty of carrying on respiration. More important than these is the loss of the elasticity of the lung, which requires that the muscles of expiration shall take up the labor of expelling the air, which they accomplish slowly and with great effort. This expiratory insufficiency involves another difficulty—the residual air in the acini is not displaced, and hence can not furnish oxygen to the blood. The concurrence of these several factors produces the most obvious objective symptom in emphysema—the embarrassed respiration. Both inspiration and expiration are embarrassed; all the muscles, auxiliary as well as ordinary, are engaged in inspiration and expiration, but the movements of the chest are very slight notwithstanding the labor, and a constant and distressing sense of the need of air is experienced; the cervical muscles are rigid and prominent, the head erect and forward to permit the easy entrance of air and to facilitate the action of the muscles; the shoulders elevated; the veins of the neck enlarged and dilated, and the face more or less cyanosed. A peculiar configuration of the chest is brought about by emphysema, which has existed for some time in young subjects. The chest becomes round; the intercostal spaces wider; the vertical diameter elongated. As the emphysema may be limited to one part, the changes in the shape of the chest will correspond. The departure from the normal consists in a circumscribed prominence more frequently on the left than the right

side ; above the clavicle, or between the clavicle and nipple, or, during coughing, the lung pushes the parietes of the chest forward at these points, producing a soft, elastic, and resonant swelling. The physical signs are very instructive. On inspection, the character of the respiration, the movements of the accessory muscles, and the extremely small excursions of the thorax in breathing are readily ascertained. On palpation, the vocal fremitus is diminished, the apical impulse is feeble, and the epigastric pulsations are increased. The heart is found to lie lower down than in the normal thorax, and the liver is also pushed lower, both due to the enlargement of the lungs in the vertical diameter. On percussion, the sonority is increased over all the emphysematous portions, and, when the whole lung is involved, extends down to the seventh or eighth rib in front, and behind to the twelfth rib in extreme cases. The hepatic dullness may not begin until the inferior margin of the ribs is reached, and even when hypertrophy exists the area of cardiac dullness is much narrowed and may not exist at all when the emphysema is extreme. On auscultation over all parts returning a resonant percussion-note, the vesicular murmur is weakened, and may entirely disappear over the lungs ; and the bronchial sounds, which are audible at the root of the lungs posteriorly in the normal state, may also disappear. In other cases, the vesicular murmur, whether enfeebled or not, is changed in character ; on inspiration it becomes rough, rude, sibilant or crackling, due to the entrance of air into the dilated and inelastic lobules, and expiration is prolonged and rough from the same cause. Expiration is usually inaudible, but an expiratory sound may be due to an accompanying bronchitis, to narrowing of the bronchioles by swelling of the mucous membrane, whence the sound has a rather sibilant character. The accompanying bronchitis, which is usually quite extensive, produces various moist sounds—sub-crepitant, mucous, and sub-mucous *râles*, which are not necessary to emphysema. The sounds of the heart audible in the mitral and aortic area are in emphysema less distinct than in the normal state, while in the pulmonary and tricuspid area they are well defined, the pulmonary second sound being sharply accentuated.

Course, Duration, and Termination.—Emphysema is an essentially chronic malady. Beginning often years before any great difficulty of breathing is manifest, it pursues a course which in its mildest form may continue during an ordinary lifetime. The least extensive cases may continue with little interference in the duties of life for many years, but the position is far different with those examples of emphysema occupying a large part of both lungs. In a pronounced case, beginning in one of the modes already described, there are constant difficulty of breathing, and cough and expectoration due to an attendant bronchitis. On taking a bronchial cold, to which they are extremely liable, or on making some sudden muscular effort, the difficulty of breathing is greatly increased, they labor to get breath, are blue in the face, sweating with their exertions, and unable to lie down. After some hours, or a day or two, the paroxysm subsides, and they are back again in the former condition, except each attack increases a little the existing mischief, the breathing is a little more embarrassed, and there are more cough and expectoration. The paroxysms of asthmatic difficulty of breathing increase in number and frequency, until after some years there is no period of partial relief. Meanwhile, the obstacles to the pulmonary circulation increase : dilatation of the right cavities of the heart and stasis in the venous system occur ; the liver swells with venous hyperæmia ; the gastro-intestinal mucous membrane also is hyperæmic, and is affected with catarrh ; the liver is congested, and the urine becomes albuminous. General dropsy now comes on, fluid accumulates in the peritoneal cavity also, but to a less extent in the pleura. The presence of fluid in the two cavities adds to the difficulty of respiration, and now the patient can get breath only as he sits up, leaning somewhat forward. This position increases the accumulation of fluid in the legs, which become blue, cold, and very painful ; the skin yields, blisters form, and, giving way, an ulcer is established from which serum continuously exudes. Such is the course of a well-defined case. Although all are not so severe, yet when emphysema occurs in an adult it is a permanent condition. It is probable that a slight amount of emphysema in a child may get well, but usually the first changes in childhood are the initial of a long series, and continue. Death may be due to the rupture of some of the dilated cells and the formation of an extensive interlobular and subpleural emphysema. The termination is often by some intercurrent disease, as catarrhal or croupous pneumonia, cerebral hæmorrhage, or paralysis of the heart. Notwithstanding the unpromising nature of the disease, all do not proceed regularly from bad to worse. Periods of improvement may take place, and the difficulty of breathing almost disappears, to return again, however, on the occurrence of a bronchial attack or some other disturbance. The cases are, as a rule, more severe in winter than in summer.

Diagnosis.—The diseases with which emphysema may be confounded are bronchitis, bronchial asthma, catarrhal pneumonia, pneumothorax, aneurism of the arch of the aorta, and cardiac diseases, with spasmodic difficulty of breathing. From bronchitis, it is distinguished by the presence of those signs characteristic of emphysema, as difficulty of breathing, increased sonority of the chest, changes in the shape and size of the thorax, and by the disturbances of the circulation and dropsy ; from bronchial or spasmodic asthma, by the fact that in the latter there are no alterations of the chest, and the difficulty of breathing is occasional and spasmodic entirely ; from catarrhal pneumonia, by the history, by the localization of the affection, by

the changes in the chest, and by the subsequent course ; from pneumothorax, by these considerations : pneumothorax is sudden, almost always unilateral, the chest much distended, the intercostal spaces prominent, the heart is displaced to the other side, succussion is present if there is fluid, which is usually the case. In aneurism there is dullness instead of increased sonority over the site of the aneurism, and no change elsewhere, and the difficulty of breathing is due to paralysis of the vocal cord, which may be seen, and to pressure on nerve-trunks. In heart-disease the area of dullness is not only present but usually increased, and the apex-beat is normal or increased, while the form of the chest and the sonority are not affected.

Treatment.—As we have to deal with an incurable disease, our treatment must be largely palliative. For the asthmatic attacks there is no remedy so efficient as the subcutaneous injection of morphine and atropine ($\frac{1}{6}$ morphine and $\frac{1}{120}$ atropine). Care must be exercised lest the morphine-habit be formed, as it is apt to be under these circumstances, and hence the injections should always be practiced by the physician, and reserved for occasions of great distress. A single injection may arrest a paroxysm, but the dose may be repeated as necessary, rarely more frequently than once in six hours. Next to the injection of morphine, most relief is afforded by full doses of iodide of potassium alone, or combined with the bromide. From fifteen to twenty grains of the iodide, and forty grains of the bromide, every two, three, or four hours, according to the urgency, may be prescribed. Chloral, which affords great relief, is very unsafe in old cases with dilated right cavities ; if given under any circumstances, it should be combined with morphine and atropine to prevent the depressing effect on the heart. A combination of morphine, chloral, and atropine is an exceedingly serviceable combination for the relief of the difficult breathing. Besides these agents, narcotic fumigation may be practiced. Pastils of belladonna, stramonium, tobacco, opium, eucalyptus, etc., may be burned, and the fumes inhaled. Such pastils are always much used by these sufferers, since they procure in this way ready and considerable relief. Inhalation of ethyl iodide is a measure of great utility, and is free from danger. As the accompanying bronchitis is an important element in these cases, measures are necessary to relieve it. The best results are obtained from copaiba, turpentine, and eucalyptol, given in conjunction with the iodide of ammonium. Excellent results are obtained from the combined administration of iodide of ammonium and arsenic, continued for some time. It is well known that arsenic increases the depth and volume of the respiration and promotes the nutrition of the lung, and the iodide is an effective remedy for the bronchitis. In these facts we have an explanation of the utility of the combination. When the bronchial secretions are insufficient, small doses of tartrate of antimony are very useful, and give great relief. Quebracho, which has lately been brought forward as a remedy for dyspnœa,

is a valuable palliative. Atropine is a remedy of great power, and has an influence over the lung, increasing the respiration and promoting the nutrition of the organ. It may distress if there is a lack of bronchial secretion, but usually the opposite state obtains, and consequently atropine can be given, as it ought to be, under these circumstances, in small doses twice a day for a long period. Of all the means hitherto proposed for the relief of emphysema, nothing has approached compressed air in effectiveness. Indeed, this is the only scientific remedy which has as yet been brought forward for the treatment of emphysema. The chamber into which air is pumped until a pressure of one and a half to two atmospheres is obtained is the best arrangement, but unfortunately they are available but in a few places. The portable apparatus of Waldenburg is convenient, easily managed, and produces good results. The object of compressed air is to relieve the breathing by supplying more oxygen, and it effects an equalization of the blood in the two systems by redistributing the pressure. By retarding the breathing and the action of the heart, the contractions are firmer, and the cavities are better emptied. The improved condition of the blood, the result of a better supply of oxygen and increased excretion of carbonic acid, induces a better state of digestion and assimilation. By breathing compressed air, the pressure is transferred from the venous to the arterial system, and while the amount of blood on the right side is diminished, on the left it is increased. The good effects of breathing compressed air are enhanced by expiration into rarefied air, which of course has the effect to draw the blood into the lungs. "Expiration into rarefied air is the specific mechanical antidote to emphysema." * The inhalation of compressed air or of oxygen may be used as a palliative to relieve the attacks of spasmodic difficulty of breathing.

The treatment of the dropsy requires a nice adjustment of means to the object. Much can be accomplished by acting on the skin and kidneys. If the heart will bear it, pilocarpine may be employed to act on the skin. Hydragogue cathartics can be given at the same time, of which the pulv. jalapæ comp. is best. A teaspoonful or two should be taken in the early morning, and pilocarpine in the afternoon. If the desired results can not be thus attained, free diuresis may be attempted while the hydragogue is also administered. Basham's mixture is an excellent combination, containing as it does a chalybeate with a saline. Niemeyer's prescription of vinegar of squill, with bicarbonate of potassa—thus forming acetate of potassa—is a good diuretic. There is no more certain diuretic than bitartrate of potassa, and it may be combined with infusion of juniper and squill. A weak solution of cream of tartar may be drunk *ad libitum*. Infusion of digitalis may also be

* "Die pneumatische Behandlung," etc., Dr. L. Waldenburg, Hirschwald, Berlin, 1875, p. 302.