

gence, amounting to rather more than 0.8 dioptric eleven hours after the instillation; and he makes the very significant remark that "hypermetropes, under the double advantage of smaller circles of diffusion and of easier tension of accommodation, lose for a time their asthenopia." The introduction of pilocarpine in ophthalmic therapeutics has made it practicable to keep up a moderate myotic action for an almost indefinite period, without injurious spasm of accommodation. In cases of asthenopia in young persons, associated with hypermetropia of low grade, pilocarpine may be employed in the form of a weak solution, instilling any desired fraction of a minim, measured by means of a slender glass pipette. The instillation may be made morning and evening, and after a few weeks at night only; or the effect may be gradually diminished by reducing the quantity used or the strength of the solution. In this way it is often practicable to tide over an attack of asthenopia in a young person without interrupting school work, and so to postpone the use of glasses for perhaps many years.

In asthenopia dependent on hypermetropia of high grade, the only effective resource is in the use of convex glasses, and these should be of a strength sufficient to correct fully the refractive error. Owing to the fact that a part of the hypermetropia is almost always latent (see *Hypermetropia*), fully correcting (neutralizing) glasses often prove less acceptable in the beginning than those of less power, but in every case the selection of glasses should be made with distinct reference to the total hypermetropia, and in the expectation of ultimately applying the full correction. In a few cases of asthenopia any exercise of the accommodation even with convex glasses is attended with pain, so that it may be found necessary to have recourse to atropine for the purpose of maintaining for a time a state of complete physiological rest. During the maintenance of the mydriasis reading may be permitted with the aid of stronger convex glasses which must be exchanged for neutralizing glasses when the accommodation is allowed to resume its function. The hypermetrope who requires convex glasses for reading sees perfectly at a distance with the same glasses, and, as a rule, finds it more convenient and comfortable to wear them constantly; but in this he may generally be permitted to follow his own pleasure. If for any reason he is disinclined to wear glasses constantly, a compromise may often be effected by prescribing spectacles for continuous reading and an eyeglass (*pince-nez*) for occasional use.

In muscular asthenopia the treatment consists primarily in the correction of the myopia, together with any astigmatism that may be present, by means of neutralizing concave spherical or spherico-cylindrical glasses. The glasses should, as a rule, be mounted in a spectacle frame rather than as a *pince-nez*, and they should be worn continuously. The relief afforded by neutralizing glasses is generally immediate and complete, but in a few cases it may be necessary to prescribe stronger concave glasses, which shall over-correct the myopia and so compel some exercise of the accommodation in distant vision and a correspondingly increased exercise of the accommodation in near work. This over-correction, which may be carried as high as three dioptries in children or in young adults with ample range of accommodation, is free from the dangers and disabilities which attend the wearing of too strong concave glasses in uncomplicated myopia.

The decentration of concave glasses outwards, or, what amounts to the same thing, the grinding of the necessary concave spherical or cylindrical surfaces on prisms of from 1° to 8° angle, set with bases of the prisms toward the nose, is occasionally of advantage by correcting the refractive error and at the same time giving some measure of direct relief to the recti interni muscles. In the higher grades of relative muscular insufficiency, division of the tendon of the rectus externus muscle in one eye or in both eyes may be indicated, but operative interference should be considered only after an exhaustive investigation of each particular

case, and generally after a full trial of less radical methods.*

In the treatment of asthenopia, whether accommodative or muscular, the chief reliance is to be placed upon the correction of the underlying error of refraction (hypermetropia, myopia, astigmatism, anisometropia) by means of appropriate glasses (convex, concave, cylindrical, or of different power for the two eyes). A practically normal relation of accommodation to convergence is thus established, and, apart from subsequent structural changes in the eyes, the glasses which perfectly correct the refractive error in youth suffice until, with advancing age, the sight begins to be presbyopic (see *Accommodation and Refraction, Astigmatism, Hypermetropia, Myopia, Presbyopia, Spectacles*).
John Green.

ASTHMA.—**SYMPTOMATOLOGY.**—Asthma is a disease characterized by attacks of true intermittent, but severe, dyspnoea, accompanied by general sibilant râles. In a typical case of the complaint the patient may retire to bed in apparently good health, and with no more warning of the impending attack than in a case of nocturnal epilepsy; but after a few hours' sleep his respiration becomes labored and whistling, so that it even may be heard by others while he is still asleep. Soon he is himself awakened by his difficulty of breathing, though if accustomed to such visitations he may endeavor to continue his slumber, and for a while succeed in doing so. Ere long, however, not only sleep, but all rest becomes impossible by the superintention of a most urgent dyspnoea, whose symptoms would indicate great peril to life in any other disease. In asthma, however, though the distress be great, alarm is significantly absent from the patient.

Careful observation now will show that the difficulty in the breathing is mainly due to some interference with the *expiration*. Unlike croup, asthma allows the air to readily enter with the inspiration, but the expiration appears as a laborious struggle which succeeds in forcing the air out only with painful slowness, rendering this process from two to four times the length of the inspiration. This disproportionate expiration is characteristic, for though the expiration is prolonged in emphysema and phthisis, yet it never equals the delay of asthma. The patients, therefore, dread the most ordinary acts which entail a prolongation of the expiration, like coughing, or even speaking, but especially laughing, for in some this is itself sufficient to induce an attack, while on the other hand a forced inspiration will often serve to break up the paroxysm.

Owing to this impeded exit the residual air increases in the lungs to such an extent that the intercostal spaces become much widened and the girth of the chest so expanded that the ordinarily worn clothes of the patient will not come together by from one to three inches. The upper abdomen also becomes similarly distended by the forced descent of the diaphragm pushing down the liver, stomach, and spleen. The walls of the chest finally seem too fixed to allow of any but the slightest expansion and retraction in breathing, and this condition gives to the patient a sense of suffocative tightness, as if caused by some external compression. Salter notes also, as a frequent symptom, a persistent itching of the chin, and often between the shoulder blades and sternum as well, supervening with the first symptoms of asthmatic breath-

*The indiscriminate cutting of the recti and even of the oblique muscles, in the hope of thereby curing asthenopia, which was at one time somewhat extensively practised, has been justly referred to by Donders as "a melancholy page in the history of operative ophthalmic surgery." Exaggerated or perverted ideas regarding disturbed balance of the ocular muscles, as the determining cause not only of different conditions of disability more or less closely simulating asthenopia, but also of all sorts of nervous manifestations occurring in other and even remote parts of the body, have borne fruit, in recent times, in reports of numerous and oft-repeated operations on one and the same muscle or on different muscles, for which it is difficult to find justification in the known facts of physiology or pathology. Operations on the ocular muscles have a legitimate place in the treatment of muscular asthenopia, as truly as in strabismus; in both conditions grave and often irreparable harm may result from a hasty or ill-considered resort to operative procedures.

ing and passing off with the full development of the paroxysm.

DIAGNOSIS.—Physical exploration of the chest now affords a group of characteristic symptoms which render the diagnosis of asthma a matter of no great difficulty. The lung distention exaggerates the pulmonary resonance on percussion and extends its area in every direction, behind the clavicles, over the heart, and downward over the regions of normal splenic and hepatic dulness. From the same cause the vocal fremitus either disappears or is much diminished in those localities where it is well marked in health. Auscultation, however, is the most decisive in its indications, for the normal vesicular murmur is quite displaced by high-pitched sibilant râles, which often attract the attention of bystanders, as they become audible to some distance from the patient. On applying the ear to the chest, however, one distinguishes very fine râles, mingled with others larger and graver in tone, which, moreover, seem to shift in location as if sometimes near to the ear, and then farther off, like a wavy passage of air over various musical tubes. In simple asthma these râles are purely sibilant, but in prolonged attacks, or when bronchitis is also present, they become more or less crackling.

As the disordered respiration continues, the sufferings of the patient for breath become extreme. His whole frame partakes in the struggle for air, which leads him involuntarily to try to expand the chest yet more and more. He strives to make immovable his back, shoulders, and head, so that from them the accessory muscles of respiration may pull upon the already tense walls of the thorax. Hence he fixes his arms or plants his elbows on a table or other support, while his head is thrown back, his mouth panting, his eyes widely opened and fixed, and his face pale and bedewed with perspiration. He speaks only in monosyllables, and resents everything which calls him off, even for a moment, from his efforts to breathe. The pulse grows small and feeble, and the patient becomes so cyanotic and cold that his wet, clammy skin and ghastly expression are apt to inspire strangers with fear of his near dissolution.

The duration of an attack varies greatly, not only in different patients, but in the same patient at different times. The attack may come on in the night and pass off soon after daylight, or it may be prolonged into a series of exacerbations and incomplete remissions for several successive days and nights, until the sufferer becomes almost fatally exhausted. In like manner the subsidence bears little relation to the severity or duration of the attack. Either as the effect of remedies or spontaneously, the breathing may become suddenly easier, the rigidity of the chest walls pass off, the inspirations grow fuller and the expirations shorter, and the patient, who but a few moments before seemed about to perish in his distress, will soon return, after a moderate expectoration of a clear frothy mucus, to regular and natural breathing, with no other indication of his recent sufferings than an expression of fatigue. At other times, especially if bronchitis supervenes, the attack passes off in a series of irregular paroxysms of difficult breathing, alternating with coughing and free expectoration. In many fully developed attacks, however, the patient has carefully to watch for its decline by avoiding all causes of exacerbation or relapse, especially from eating, so that some asthmatics are obliged to go to bed fasting if they are to pass that night free from dyspnoea.

ETIOLOGY.—In asthma, as in other markedly spasmodic diseases, the afferent impression which induces the attacks varies indefinitely, both in kind and in seat. The sensory nerves, however, which are distributed to the mucous membrane of the respiratory tract, including the olfactory, afford the most frequent instances of the curious impressibility which excites reflexly the asthmatic spasm. On this account bronchitis itself takes the lead, for asthmatic breathing occurs in so large a proportion of both acute and chronic forms of this affection that some writers have gone the length of ascribing all asthmas to bronchitis. It is easy to show, however, that asthma

lacks no element of a true neurosis, and that in many typical cases there is no bronchitis whatever. Yet, so great is the proclivity to it in bronchitis, that even comparatively transient affections, like measles and pertussis, sometimes entail a lifelong asthma as a sequel to the bronchial irritation attendant upon their course. In the initial or "dry" stage of acute bronchitis, along with the sense of soreness and tightness across the chest, auscultation reveals the presence of true asthmatic wheezing, while in chronic bronchitis asthmatic attacks often occur upon very slight provocations, such as by rising too suddenly, or from attempting too long a sentence in talking.

After the irritation of bronchitis, the list of excitants of asthma which take their start from the sensory nerves of the respiratory mucous membrane varies in a most extraordinary degree. Nearly every asthmatic has his speciality of the kind, so to speak, often with a most unaccountable caprice of choice. The writer has known of a gentleman who, while in his room on an upper floor, yet could tell at once by his breathing that buckwheat flour had just been brought into the house. The proximity of certain animals, especially cats, will induce an attack with many asthmatics, who may suffer from this cause for a long time without being aware of its origin until they accidentally discover that the tightness comes on so soon as they come near a horse or a dog, or pay a visit to a menagerie. The proclivity to asthma from deranged innervation within the nasal cavity is also illustrated by numerous histories of cures by the removal of polypi or other causes of nasal obstruction or irritation. The smell of powdered ipecacuanha is often mentioned as a similar excitant, but although this may be ascribed to irritation by minute particles of ipecac inhaled—and the like may be said of asthma from the inhalation of mustard or of the fumes of a sulphur match—yet such an explanation cannot hold good in asthma caused by the smell of violets or of other fragrant flowers. In fact nothing can be more whimsical than the behavior of asthma as regards either what may be resented as an ingredient of the air inspired, or simply from the general character of the outer atmosphere. One asthmatic may find comfort in the air of a particular locality which another asthmatic can enter only at his peril. Salter mentions the instance of two friends who could not exchange visits at their country houses, which were on opposite sides of a ridge, though both were suited with the air of London. The air of large cities, in fact, despite its smoke and dust, agrees oftener with asthmatics than does the pure air of the country.

Next to the respiratory tract, the most frequent excitants of asthmatic attacks proceed from the alimentary canal, especially from its gastro-duodenal portion. Most asthmatics, indeed, are also dyspeptics, and are thus doubly obliged to be particular in their dietary. The list of forbidden articles is singularly varied, as we might expect from the range in this respect among dyspeptics as a class. Some will have asthma if they take cheese, others almonds, others apples or wine or tea or tobacco, etc.; the peculiarity being that the particular idiosyncrasy is generally consistently adhered to, perhaps for many years, or at least as long as natural tastes or likings are apt to last. With many patients, however, it is not so much a particular article which brings on a paroxysm, but a too hearty meal for them of any kind. On the other hand, constipation is the sure provocative with some who are also often promptly relieved by a cathartic. In women, uterine derangements have their share in the causation of asthma, though not as frequently as they serve to excite other spasmodic diseases; while a certain proportion remains whose attacks seem to be induced solely by mental excitement, particularly of a depressing kind.

Among the special predisposing causes of asthmatic seizures is the state of sleep, for the majority of distinct attacks set in after the patient has been asleep for some time, and oftenest during the hours of profound slumber, after midnight. Some asthmatics are obliged to keep awake after noting certain of their usual premonitory

signs, or the attack will surely develop if they happen to sleep at all. The relation of sleep to the attacks is also well illustrated in peptic asthma, for though the offending article of diet be taken in the morning, yet it will not be until its customary hour in the night that the asthma which it induces will come on. This chronometry of asthma exemplifies the real but unperceived continuousness of the spasmodic nervous diseases, in all of which the outbreaks are sudden only in the manifestation of certain symptoms, and which mere symptoms, like spasm, etc., are therefore too often mistaken for the whole disease. The reasons which have been adduced by various writers for this nocturnal feature of asthma, as in the analogous instance of nocturnal epilepsy, are too hypothetical to call for extended discussion. It is interesting, however, to note that the mere fact of darkness seems to dispose to the attacks. Not a few patients can prevent them by keeping a light burning brightly in their rooms, while if the light be put out they will soon wake up with difficult breathing.

Asthmatic dyspnoea is also occasionally secondary to other diseases or morbid states, in which case it ranks only as a symptom of them. Thus, in heart disease, particularly in mitral stenosis, the widespread congestion of the bronchial mucous membrane may excite real asthmatic symptoms, which, moreover, should not be confounded with true cardiac dyspnoea. In the latter, the patient resembles one who is out of breath from muscular exercise, as after running, but cardiac asthma, properly speaking, shows the same derangement of expiration as ordinary asthma, and is evidently due to the bronchial hyperemia acting as a reflex excitant. Toxæmia also sometimes produces asthmatic attacks, especially in gout and in uræmia. In the gouty cases the attacks are sudden, nocturnal, and quickly accompanied by a great bronchial flux, which may be pinkish from capillary hemorrhage. A patient of mine once expectorated two large basinfuls of such mucus between midnight and morning, but after three such attacks they ceased and never recurred afterward. In gouty asthma alarm is wholly absent, but not so in uræmic asthma. Here again, as in the cardiac cases, the dyspnoea should not be mistaken for asthma, if it be due, as it commonly is, to pulmonary oedema or to pleuritic effusion. True uræmic asthma is characterized by sudden attacks of difficult breathing with great terror, and often also with severe palpitation of the heart, which is usually much hypertrophied from the arterial obstruction of chronic renal disease. After a few attacks, if not after the first one, the breathing remains permanently shortened, and the patient dreads the slightest cause of cardiac excitement. In most cases uræmic asthma is a late, and not a favorable symptom of chronic Bright's disease, particularly of the granular variety, and it is commonly associated with abundant light-colored urine of low specific gravity, with or without albumin, and with evidence of general endarteritis as illustrated by the tortuous and rigid temporal and radial arteries. In one case, however, seen by me in consultation, the kidney affection seemed to follow the asthma rather than to precede it. The patient, a gentleman about fifty years of age, was suddenly seized, while apparently in perfect health, with extreme dyspnoea. His physician on arrival tested his urine and found it heavily loaded with albumin. This albumin, however, wholly disappeared in a few days, until after a fortnight, when he had another exactly similar seizure, also in the daytime. The interesting circumstance connected with the second seizure was that he had sent a specimen of urine, passed only an hour before the attack, to be examined, and it was found to be wholly free from albumin and of normal specific gravity; but some tested immediately after the seizure set in became nearly solid on boiling. This observation of the reappearance of albumin only at the attacks, with its gradual but ultimately final disappearance until another fit of dyspnoea arrived, was repeated a number of times, once by myself, as daily examinations of his water were kept up. He finally succumbed, some months later, to extensive effusions in both pleuræ.

Asthmatic attacks are also sometimes plainly associated with the disappearance of chronic skin eruptions. A patient of mine always became asthmatic whenever an old eczema of the chest began to subside, until he found that he could rid himself of the infliction by an artificially induced eczema with croton oil.

AGE.—Asthma may begin at any age. An intelligent patient of mine, seventy years old, stated that the disease was observed in him on the first day of his life. There is, however, a special proclivity to it in the first decennial, owing to the predisposition of children to bronchitis. Of 225 cases, Salter had 71 under ten, and in 11 of them it began in the first year. The prognosis of asthma is better in childhood than later on, as it is frequently outgrown after puberty, particularly if the causes of bronchitis be carefully avoided. The cases which begin in adolescence are relatively few, and are then generally of the purely spasmodic form. But in middle life the proclivity to asthma again increases with the greater exposure from outdoor occupations, but, unlike bronchitis, asthma as a new disease begins to fall off, and progressively decreases in its ratio till seventy. The common impression that asthma is a disease of old age is a mistake, arising rather naturally from the frequency of chronic bronchitis with asthmatic wheezing among elderly persons.

SEX.—The influence of sex is considerable, the preponderance of males being about double that of females. That this, however, is due to the greater exposure of men to causes of bronchitis, is shown by the fact that the cases of the pure spasmodic variety are about equally divided between the sexes.

HEREDITY.—Asthma belongs also to the markedly hereditary diseases, as might be expected from the characters of its common accompaniments. An inherited proclivity to bronchitis is observable as often as a family tendency to phthisis, while neuroses, on the other hand, are more frequently of constitutional origin than any other class of affections. About thirty-five per cent. of all asthmatics, therefore, will show some sign of heredity, and oftener from the paternal than from the maternal side—a fact, moreover, in keeping with the greater frequency of the disease among men.

PATHOLOGY.—Asthma has no characteristic anatomical lesions. That extensive pathological alterations are often found post mortem is quite true, but in most cases they are caused by intercurrent affections, particularly by bronchitis. Under this head come hypertrophy of the circular muscular fibres, with consequent narrowing of the bronchioles, it may be even to occlusion, collapse of lobules, emphysema, and dilatation of the right side of the heart, with the various sequelæ of these conditions, to be detailed in their proper place (see *Bronchitis*). But there are some organic alterations which may be ascribed to the labored respiration of asthma alone, when severe and prolonged attacks come so often that the parts have no opportunity to return to their normal state during the intervals. That this is the occasion of such changes appears from their complete absence in those patients who have perfect intermissions between the attacks. The first of these effects is dilatation of the right heart, caused by long labor in the difficult propulsion of blood through the lungs so soon as apnoea occurs in any form. During a paroxysm of asthma, the left heart and the systemic arteries are relatively empty and the pulse is small, while the systemic venous system from the right auricle backward is everywhere overloaded. The heart beat is then found, not under the nipple, but in the scrobiculus cordis; partly, it is true, from the displacement caused by the dilated left lung, but equally also from the distention of the right ventricle. Another constant result is emphysema, or permanent overdistention of the air vesicles, caused by the progressive accumulation of the residual air from the imperfect expiration. Emphysema may thus be found in old asthmatics, whether they have had chronic bronchitis or not. Lastly, from the combined derangement of the pulmonary circulation caused by the intermittent apnoea and the permanent emphysema, we have a tendency to bronchial flux to relieve the congested

vessels, which finally adds chronic inflammation to chronic hyperæmia, and thus establishes the vicious circle of impeded circulation causing bronchitis, and bronchitis in turn causing progressive circulatory impediment.

These slowly induced effects finally produce those changes of personal appearance which mark old asthmatics. As the general nutrition suffers from the persistent congestion of the liver caused by the impeded outflow of the right heart, these patients are usually thin, pale, or cyanotic, and with deficient muscular power. The eyes are prominent and watery, the voice is weak, the gait slow and measured, and the back rounded, often to great deformity. The head, however, is always thrown back between the elevated shoulders, and the trunk of the body is kept so rigid that the arms hang passively, swung by the movements of walking.

Leyden endeavored to demonstrate that the cause of asthma lies in the presence of sharply tipped octahedral crystals, found abundantly in the expectoration which terminates a paroxysm of asthma, and which, he supposed, by their numerous fine points set up a reflex irritation of the terminal branches of the vagus in the bronchial mucous membrane. This theory, however, is sufficiently negated by the discovery of the same crystals in the secretions of other bronchial affections in which there is no asthma. That asthma, instead, is essentially a functional neurosis is readily apparent when the disease is studied in uncomplicated cases, for in them, though there be neither bronchitis, heart disease, nor toxæmia, we have typical attacks developing in association with phenomena which belong to nervous diseases alone. Of such phenomena we would cite: 1. Extreme suddenness of onset, as the immediate asthma caused in some by certain odors. No less sudden also in many cases is its departure, as upon the inhalation of certain fumes. This feature militates also against the theory of Weber, who ascribes asthma to turgescence of the mucous membrane, narrowing the calibre of the bronchi as an acute coryza impedes breathing through the nose. Störck lent support to this view by laryngoscopic observation of tumefaction of the tracheal mucous membrane as far as the right bronchus in an asthmatic during an attack. Bristowe, moreover, cites the rapid subsidence of cutaneous turgescence in some cases of urticaria evanida as affording some support to congestive swelling of the bronchial mucous membrane being a factor in the etiology of asthma. But though it be freely granted that the agonizing struggles of an asthmatic for air may have considerable effect upon the circulation of the bronchial walls, yet the fact remains that no known swelling, however evanescent, vanishes so quickly as some true asthmatic dyspnoeas vanish, the patients becoming natural often more speedily than is common after either epileptic or neuralgic attacks. 2. Like other spasmodic neuroses, whether sensory or motor, asthma often has characteristic prodromes of the attacks. One of the most common is a feeling of almost irresistible drowsiness, giving way to which, the patient well knows, will be followed by the old dread awakening. With some, on the other hand, unusual wakefulness is a sure precursor. As in epilepsy and in migraine some are warned by the temper becoming very irritable, or the spirits causelessly depressed, while others experience unwonted buoyancy of spirits. Moreover, as in these neuroses, the attacks are sometimes preceded, but oftener followed, by an abundant flow of pale, limpid urine. 3. Mental influences alone are known both to excite and to suspend the attacks with some. In certain patients a fit of anger may induce an attack immediately, in others, more significantly still, it invariably insures the attack during the succeeding night, long after the angry emotion is gone or forgotten. 4. It is only in functional neuroses that we find many and widely differing exciting causes. Thus epilepsy has been wholly relieved by the expulsion of a tapeworm, or of a renal calculus, or by trepanning. But in this respect asthma surpasses all other complaints, and the bearing of this fact upon the nervous character of the disease appears when contrasted with bronchitis, which involves, moreover, just the same parts which

asthma affects. Bronchitis certainly, as well as any other disease with palpable lesions, cannot be excited by such a motley array of influences as the smell of cats or of violets, the eating of raisins or nuts, by constipation, by depressing emotions, or by the extinguishment of a light. 5. A decisive consideration is to be noted also in the intermediate condition between the paroxysms. In typical asthmatics in whom no organic changes have yet been induced, such as emphysema or the effects of chronic bronchitis, the existence of asthma cannot be even guessed. The patient shows to inspection and to physical exploration of the chest no more signs of being subject to violent and prolonged attacks of dyspnoea than an epileptic's muscles tell of his convulsions.

MECHANISM.—Asthma, therefore, may be regarded as essentially a derangement of the innervation of the respiratory apparatus, disturbing the rhythmical succession of contraction and relaxation by a muscular cramp, which interferes chiefly with the act of expiration. But the mechanism, so to speak, of the asthmatic paroxysm itself is by no means agreed upon. The majority of authorities ascribe it to narrowing of the bronchioles by spasm of their muscular coat, while others maintain that it consists in spasm of the diaphragm and costal muscles. Each of these theories may be said to explain what the other leaves unexplained, and hence it is doubtful if either of them alone can be regarded as adequate. The arguments in favor of the latter theory are:

1. During the attacks the whole aspect of the patient is that of extreme external muscular rigidity. Both the thorax and abdomen appear fixed and immovable, and show none of those strong heaving and expansive efforts which are visible in other forms of dyspnoea. Thus, in asthma, the diaphragm remains depressed, as if arrested in inspiration, and the muscles of the distended abdomen grow hard and tense as they labor in vain to overcome the resisting diaphragm and thus assist expiration. From the powerful contraction of the abdominal muscles it even happens that the lower ribs often bulge during the effort at expiration. On the other hand, when there is obstruction in the respiratory tract, as in laryngeal croup, oedema glottidis, etc., the phenomena are all different. The difficulty is then plainly in the inspiration, and not in the expiration, and the ribs to which the diaphragm is attached actually sink in, even during inspiration. Why obstruction in the bronchi should reverse all these effects is not explained.

2. The theory of bronchial spasm fails to account for the difficulty of expiration in asthma. If contraction occurs in the tubes, it must interfere with both inspiration and expiration equally, unless it can be shown that the circular fibres have a valvular action at the points of contraction, admitting the incoming, but interfering with the outgoing, current. This phenomenon, however, has never been induced in animals experimentally, and is even difficult to imagine. Moreover, that nothing of the kind occurs is proved by auscultation, for a valvular obstruction to the expiration would totally alter both the quality and the pitch of the expiratory sibilus, which is not the case.

3. On the other hand, the theory of diaphragmatic spasm explains why inspiration is easier than expiration in asthma, because it is well known that partially cramped voluntary muscles, like the diaphragm, can always be stimulated to further contraction, though still disinclined to yield to relaxation. This appears strikingly in tetanus, in which disease the tonic rigidity of the muscles never wholly gives way, although every few moments fresh and powerful contractions occur in response to the slightest external impressions. Meantime, the statement that the depressed state of the diaphragm is a passive condition due to the overdistention of the lungs with residual air, is negated by the active muscular contraction of the abdomen above referred to, which is quite different from the passive distention of the abdominal walls when the diaphragm is depressed in emphysema.

4. The asthmatic paroxysm is always aggravated by certain movements which confessedly occur only in the