are (a) an estimate of exercise tolerance immediately before enlistment, (b) the effects of infection, shell shock, gassing, etc., after joining, or any other event happening on active service which is known notably to aggravate. In cases of real heart disease arising before enlistment aggravation may always be considered to have occurred where any material service has been given. Precisely the same points come up for consideration as in the "effort syndrome" group. In general, in a case of heart disease, the lowest percentage disability given for the diagnostic group to which the man belongs in the disability table may be taken as the *maximal* (though not necessarily the *minimal* figure) for the disability at enlistment. This is recommended because although a lesion, such as early and uncomplicated mitral stenosis or aortic reflux, may have passed unnoticed by the recruiting board, being often in the pre-diagnosable stage, such lesions, in the presence of complications, could scarcely have remained undiscovered. The complications may therefore in general be viewed as "aggravations." Thus, in a case of mitral stenosis arising in civil life the disability on enlistment should be placed no higher, though it may be placed lower, than 30 per cent.

Where there is uncertainty the benefit of the doubt should be accorded the man, and the original disability fixed at a low percentage. If in arriving at the full disability, 10 per cent. has been added for poor development or for rheumatic fever *acquired before serving*, then it must also be added to the assessment of disability on joining.

THE COMMON FACTOR IN DISORDERED ACTION OF THE HEART.

BY

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THE group of cases spoken of as disordered action of the heart (British), neuro-circulatory asthenia (United States), effort syndrome (Dr. T. Lewis), irritable heart of soldiers (Da Costa), includes those having the common symptoms of breathlessness, palpitation, precordial pain, and exhaustion. Additional symptoms suggesting the functional involvement of every system in the body may be present, but, on account of their prominence, those referring to the circulatory and the nervous systems are the most evident.

That these two systems are disturbed is shown by the anxious, listless expression, the nervousness, tremor of the muscles, increased reflexes, dizziness, giddiness, or fainting, and changes in the blood pressure and pulse. We could subdivide the cases into groups, such as the psychic, cardiac, involuntary neuro-muscular, or any other which one may fancy; but such a procedure, while it may be descriptive to some extent, does not advance us in dealing with the condition, and might be misunderstood.

"D.A.H." is always secondary. Its primary cause may be found as far back as the family history where life began under the burden of some hereditary taint, but usually the primary factor will be found as some infection, accident, injury, or in single or repeated mental shocks. Such events will be evident in the history of the individual as a turning-point in his life, as since then he has been unable to make the physical effort he had formerly been able to accomplish without distress.

As a matter of fact, the condition of the circulatory system during an acute attack of fever does not differ materially from that which we find in D.A.H. In both we have the same breathlessness, palpitation, precordial pain on exertion, and vasomotor disturbances on changes in position or after exertion; in some cases the same fast pulse; in others, like typhoid or cerebro-spinal fever, a relatively slow pulse. Our custom, when these symptoms appear during the course of a fever, is to return them under the nomenclature of the infection; when they are present after all obvious signs of the illness have disappeared, to speak of them under the diagnosis of D.A.H.

It has become so usual to consider that all cases of D.A.H. must be accompanied by a rapid pulse while at

rest and after exertion, that I give the following case report of a patient with a comparatively slow pulse, but who has undoubtedly suffered from the condition since boyhood.

Pte. B., 26th Battalion C.E.F., aged 38; born in England. Total service thirty-four months, in France six months.

Complaints.—Breathlessness, dizziness, precordial pain, exhaustion.

Family History.—Mother, aged 68, has always been nervous and weak. Father died of cancer of stomach, aged 56. Five brothers and five sisters. One brother killed in the Somme fighting, another discharged from the army as medically unfit, cause not known; the remainder healthy as far as he knows.

Personal History.—The patient had measles in childhood; rheumatic fever in 1909, when he was in bed for eleven weeks. He has had three attacks of acute tonsillitis. He was not able to play games at school because he was never strong enough. He worked at his trade of carpenter in England with occasional spells of weakness and dizziness until 1898, when he joined the Coldstream Guards as pioneer corporal, and served with them in England and South Africa. During this service he had frequent fainting attacks, and was discharged as medically unfit in May, 1906. He went to Canada in 1911, and worked at his trade with a few interruptions on account of weakness and dizziness. In 1914 he joined the 26th Battalion, and was discharged medically unfit on July 6th, 1915. He then joined the militia of Canada in August, 1915, and did home duty until joining the — Battalion as sergeant-major. He did eight months' training in Canada, carrying on with difficulty, as he constantly fell out of route marches on account of breathlessness and weakness, and had frequent fainting spells. He did five months' training in England with similar complaints. He reverted to a private and went to France in October, 1917, but was unable to carry on either as regards route marches or front line work, and was evacuated to England on March 15th, 1918, as D.A.H.

Condition on Admission.—Height 6 ft.; weight 164 lb.; extremely depressed and expression listless; tonsils ragged, not enlarged; teeth good; blueness of the hands; no clubbing of the finger-nails. There is not an area of hyperaesthesia. *Urine:* Specific gravity 1018, acid, no albumin, no sugar. Eye and knee reflexes normal. He had an occasional spasmodic twitching of the muscles in different parts of the body. *Circulatory System:* Pulse 60; after a measured exercise 100, in one minute 60. Heart apex beat fifth left interspace in nipple line fairly diffuse. Area of cardiac dullness: left limit outside left nipple line 12 cm. from the mid-sternum. *Sounds:* A faint systolic murmur in all areas, heard on lying down only. Rhythm irregular; immediately after exercising the disturbance disappears; with deep respirations the irregularity is increased.

FIG. 1.—Pulse tracing with ordinary breathing.

FIG. 2.—Pulse tracing with forced breathing.

Under digitalis, *mx* four times a day for four days, the pulse remains as shown in the tracing. Under tincture of belladonna, *mx* four times a day for four days, the rhythm became quite regular, and was then not disturbed by increasing the respirations.

While it is not usual for these cases to be accompanied by a gross pathological lesion, the presence of such a change does not prohibit a coincident D.A.H. which may depend upon the same or some other etiological factor. In any case an obvious lesion, when present, is the chance involvement of a susceptible tissue, and is quite apart from the actual bodily changes which are present in D.A.H. I might express this in a different way as "history of rheumatic fever, typhoid fever, or any other illness is of sufficient importance to be considered by itself, quite apart from any local change."

In the case reported we have (a) disordered action of the heart which has been present since boyhood; (b) a pathological change in the heart (hypertrophy and some irregularity of the *a-c* interval); (c) a dominant vagus nerve.

In the ordinary normal person we do not find the nervous connexions of the heart especially evident, as they

are nicely balanced, or, at least, are only evident under special stimulation.

Such response of heart muscle to vagus as occurs in this case will throw doubt on Sir James Mackenzie's suggestion¹ that this demonstration is in favour of a heart muscle which has escaped damage. In this case at least, where the vagus overcomes not only its usual reticence, but also an abnormal heart muscle, we are driven to consider some factor which is behind the nerve, stimulating or intensifying its action to determine its ascendancy. The usual case of D.A.H., on the other hand, has a rapid pulse because the exciting factor has an affinity for and enhances the action of the cardiac sympathetic.

In the diagram I have shown the parts of this subject we know. They are predisposing factors which initiate the bodily changes giving rise to end results of circulatory disturbances and physical and psychological exhaustion. Between these two there must be a common factor which regulates the disturbed intercellular phenomena. I do not think we should be diverted from such a solution because the primary factor happens to come from various directions and in different forms.

For a solution of this problem the autonomic nervous system must form one part of the equation. Anatomically, this system is divided into:

1. Cranial.
2. Thoracic - lumbar or sympathetic.
3. Sacral.

The sympathetic division is widely distributed throughout the body, while the cranial and sacral portions have only a restricted field. Physiologically, the divisions differ, as, when branches of the middle or sympathetic division meet in any organ with branches from either the cranial or sacral portions, their effects are antagonistic. Normally the opposed actions are balanced, but under various conditions one or other section may predominate, and, in the heart in D.A.H., we may find either the vagus representing the cranial portion, or the sympathetic representing the sympathetic portion in the ascendancy.

A second factor in the equation would be the circulating fluids which, in health, contain the nutritional and chemical needs of the body and act as a nicely balanced medium for the correlation and mutual benefit of the different cells and functions. From our slight but gradually increasing knowledge we know that these fluids are the chemical results of cytoplasmic activity of all the different cells, some merely metabolites, but others of a specific nature differing chemically and physiologically but greatly dependent on one another for their entrance into the circulation, and all required by the individual systems in a pure state in order that they may perform their functions correctly.

We have abundant evidence that these bodily secretions are further influenced by the infections, by prolonged exertion, and by emotional excitement. During the siege of Paris, 1871, Graves's disease was common. Alexander notes a case of Graves's disease following a bomb explosion.² In this clinic almost every day we see cases with some enlargement of the thyroid, and symptoms which suggest its disturbed function. While recognizing that hypertrophy of this gland does not necessarily include an altered function, the possibility of a thyrotoxin remains uppermost in our minds because we have no method of determining its presence or absence in the blood.

Ramond and François,³ during a few months of 1917, were able to collect 26 cases of confirmed Addison's disease in their hospital sector in France. They concluded that the increased evidence of this condition is due to the slow, progressive, positive suprarenal insufficiency, in consequence of the continual state of moral and physical tension inseparable from this prolonged war. It is also of importance in this connexion that two of their cases were associated with Graves's disease.

W. B. Cannon⁴ has shown that in the primary emotions Nature has increased our reservoirs of power by increasing the output of adrenalin, by mobilizing the energy-giving sugar of the liver in the circulation, and by increasing the coagulation time of the blood. In this way the organism is made more effective in a display of energy; fatigue is abolished, and some provision made for the conservation of blood in case of accident. Such responses to the emotions are in the nature of reflexes, and denote a neuro-chemical relationship between the circulating fluids and the nervous system. By stimulation of the sympathetic Cannon was able to deplete the adrenal glands of their active principle in a very short time. It will not be denied that a similar stimulation occurs in the recruit during the time he is being imbued with the ardour and the skill of warfare, as well as during his presence in the field when a soldier.

In the infectious diseases and other debilitating conditions the function of the adrenal gland became altered in a similar manner. F. Lucksch⁵ gives the disturbance as a depletion of the gland itself. He gives the normal amount of adrenalin as 4 mg. per gram of dry adrenal weight. This figure falls in the infectious and other diseases, and may reach 0.35 mg., or in infants 0.13 mg. In Addison's disease the figure is lowest and in nephritis the highest.

That depletion of the adrenals in itself has a marked influence on the general economy, and that it must influence the functions of all the

FIG. 3.

organs, is shown by the work of Athanasia and his pupil Grandinesco, who are quoted by Gley.⁶ They found that adrenalin, by the tonic influence it exerts on the endothelium of the blood capillaries, regulates material changes between the blood and the interstitial plasma of the tissues, so that, if the secretion of this product is abolished, these exchanges are put in a state of profound disorder. In the light of this evidence one might be tempted to consider the positive suprarenal insufficiency as the solution of our problem, and, while important, it is only one of a number of chemical products found in the circulating fluids, each one of which is dependent on another for stimulation and assistance in its functions, and each influenced by and influencing all the other cells of the body, so that a consideration must include the entire chemical content of the blood. Our information so far then shows that in the circulating fluids we have products of a chemical nature; that disease and nervous stimulation affect at least the quantity of the chemical elements entering the blood.

That a further qualitative change takes place is also certain, because the alkaline balance of the mixture has been altered. Bayliss,⁷ Moore,⁸ Barcroft,⁹ and other physiological chemists are agreed upon this point. At present they happen to be engaged in a controversy as to whether it is the alkaline salts or the amphoteric proteins which are interfered with, and as to whether the protection of normal blood acts as a "buffer" or as a "tampon," but the general opinion seems to be that the hydrogen ion concentration of the blood has been interfered with. This is an important fact, and must be associated with the disturbance of the balance in the internal secretions.

There is, as yet, no absolute proof that this acidosis in D.A.H. is the result of a chemical change in the internal secretions, but the certainty of a quantitative change in some of them I have shown, and as chemically they are dependent upon each other but cannot replace one another, it is surely a fair inference that, in the reciprocal reactions of excitation and inhibition which go on between them, and when their balance has been lost as we have shown in this condition, one at least of their number, let us say, in an attempt to replace the functions of another, forms compounds which are abnormal and acid in reaction. This is no doubt rendered easier by reason of increased sugar

present in the blood, which so easily lends itself to the formation of acid compounds.

Clinical observation of the respirations in cases of disordered action of the heart does not favour the theory of acidosis due entirely to deficient lung ventilation. The respiratory centre and muscles come primarily under the influence of altered circulating fluids, their function is interfered with, and the increased contribution of hydrogen ions they make to the circulation is secondary.

We know from physiological and from clinical experience in different diseases that certain compounds stimulate one or other divisions of the autonomic nervous system. The case I review in this paper is one instance where the vagus is under such control. The rule, as we know, is for stimulation of the sympathetic. I only point out that such is the action of various abnormal circulating fluids.

In D.A.H. it is not only the respiratory and autonomic systems which are disturbed, but the changes in the function of the psychic, cardiac, locomotor, and other systems are so pronounced as to suggest the cases being grouped into psychic, neuro-muscular, cardiac, etc. Such abnormal intercellular phenomena are accompanied by a mechanism apart from the nervous system, and must result from the intermediary action of the circulating fluids acting either (a) directly, by bathing the cell in an abnormal chemical compound which may initiate a change in the chemical reaction of the cell itself, or possibly change the arrangements of the protoplasm and nucleus; (b) more indirectly, through the action of these fluids on the endothelium of the capillaries interfering with material exchanges between the blood and the interstitial plasma.

I have attempted to prove that it is in the body fluids we have the common factor of disordered action of the heart. The rôle of the autonomic system is that of the small child who starts the motor car and is unable to pull the levers of control. By means of its more or less continued stimulation, a vicious circle begins—(1) stimulated autonomic system; (2) altered body fluids; (3) altered function—in which all systems, including the autonomic system, take a part. Similar changes take place, we have seen, in the acute infections and other diseases, and are followed by similar symptoms; their importance in the history of D.A.H. being that once the vicious circle has been created, it is entered upon again more readily. The relation of single or repeated mental shocks depends on the degree of shock and the stability of the autonomic nervous system.

I have never seen a satisfactory explanation of the symptoms of D.A.H., but, having followed me so far, if you will understand the sense in which I use the word "exhaustion" as being synonymous with malnutrition of the cells owing to the chemical alteration of their necessary food, I will try and apply them to my solution of D.A.H.

Breathlessness, especially on exertion, is the most common symptom of this condition. If we were dealing with a normal respiratory centre and muscles, and with blood which was normal, except for the addition of hydrogen ions as a result of deficient lung ventilation, we would surely have such a response of the centre and of the muscles that any disturbance of the potential alkalinity of the blood would be corrected.

The arrangement, we have seen, is that the circulating blood has its alkaline balance disturbed, quite apart from the respiratory system, and that a further disturbance of this balance occurs as a result of deficient lung ventilation. The respiratory system in these cases cannot be judged by ordinary standards. The centre bathed by abnormal fluids, with function either inefficient or exaggerated, is on a different plane. The respiratory muscles have every evidence of exhaustion. We know that with increased hydrogen ion concentration the avidity with which the blood gives up its oxygen is accelerated, so that, considered clinically, it would appear that both the centre and the blood required to be further activated by carbon dioxide in order to obtain the necessary response for ordinary effort. This explanation does not pretend to be anything more than an attempt to correlate the clinical appearance of respiratory action with certain changes in the blood. I bring it forward with considerable trepidation, but with the certain feeling that an analogy does not exist between the experimental injection of lactic

or other acids and the autogenous disturbance of circulating fluids such as we have present in these cases.

Precordial Pain.—Starling¹⁰ has shown that the reserve power of the heart is enormous and is dependent almost entirely upon its nutrition. The cardiac pain, whether accompanied by hyperaesthesia or not, is merely the distress signal of an organ compelled to work in spite of a food supply, at least altered chemically. In Meakin's series of cases of hyperaesthesia¹¹ two cases with a known toxic factor support this—one an appendix case with an area of hyperaesthesia on the right abdomen, as well as a precordial area; and the second case, one of chronic dysentery with an area of hyperaesthesia on the left abdomen, as well as a precordial area. In both of these cases, with the cure of the primary condition and the disappearance of the toxin, not only the local but also the precordial hyperaesthesia disappeared.

Palpitation is the outcome of an overacting heart, or of extrasystole, and with the exhaustion, the vasomotor and other symptoms are explained by the changed character of the body fluids interfering with function.

This paper must not be considered as more than clinical, based on observation and on deductions which the writer hopes are within reason. It should direct attention to the importance of all debilitating factors in the life-history of the individual, which, although disappearing without trace, nevertheless have created a vicious circle which readily recurs, and under any stress will reappear and alter every function of the body, mental and physical.

The final solution of problems involving disordered functional correlations of a chemical or neuro-chemical nature must remain in the hands of the physiological chemists.

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INTRAVENOUS INJECTIONS OF ANTIMONIUM TARTARATUM IN BILHARZIOSIS.

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SINCE May, 1917, we have been treating bilharziosis (rectal and vesical) at the Khartoum Civil Hospital by the intravenous injection of antimony tartrate, and I am convinced of its efficacy.

So far as our present knowledge goes—leaving out of consideration for the present antimony—there is no cure for bilharziosis excepting time, and there is no drug to which bilharziosis will directly respond even in the feeblest way. Symptoms may be alleviated, and even temporarily suspended, by rest in bed, by dieting, and by symptomatic treatment; but, after all is said and done, there is, so far as I know, no drug (again excepting antimony) which has the slightest direct effect on the career of the *Schistosomum haematobium* in the portal circulation and its tributaries.

The intravenous injection of antimony tartrate (details of which I have recorded elsewhere¹) has a profound effect on the symptoms of bilharziosis. One may safely say that, so far as subjective and objective signs are concerned, a cure is effected; one cannot say at this present time that the cure is permanent (it certainly lasts for weeks and months). The permanency of the cure still remains to be probed.* The remedy, no doubt, must be administered with ordinary care, and with the judgement which obviously is due whenever a powerful and toxic drug is used, but it appears to me that antimony tartrate

* Cases so treated months ago are under observation, and will be reported on in due course.