illness during pregnancy frequently ending in the death of the mother about 270 annually—in all, just under 700 deaths of mothers, on the average of three years, 1914–16. Puerperal convulsions, we are assured, are wholly preventable if the antecedent condition is treated in time, and it is likely that were the conditions under which the others arise wholly in view from their onset, we should be able to anticipate a reduction in them also.

It is, in my opinion, the distinct duty of the State to give earnest heed to the whole position of maternity, both pre-natal and post-natal, and this not only in its own interest and the interests of the empire, but also in the interests of the mothers themselves, who, if in straitened circumstances, as too many of them are, should be assured of all the medical skill and nursing facilities that are accorded to their more fortunate sisters in the higher grades of life.

The larger towns have maternity hospitals, and occasionally ante-natal beds are to be found in them; ante-natal dispensaries are just coming into being. But they have not yet fully enlisted the active interest of the general body of medicine, and without the active help of the general practitioner I am of opinion than any scheme will have difficulty in materializing.

But in order to co-ordinate all the functions of medical adviser, nurse, and welfare visitor, welfare centres are an absolute necessity, and they must be numerous enough to be available to every group of the industrial population. The dispensary should lead where necessary directly to a hospital bed, while the dispensary and hospital staff should be drawn from the practitioners and consultants of the district.

All this is the work of local organization, but there is a phase of the question which requires direct State help, not only of a financial character. When we think of ante-natal hygiene each one has in a general way a conception of healthy maternal life, but the point at which changes in physiological processes begin to lay the seeds of definite disease are by no means well understood, even by the general body of medical men, and I believe the State might greatly help in this direction by appointing a commission to inquire into the whole question of ante-natal pathology, with a view to determining in a precise form at least some of the data upon which a doctrine of ante-natal hygiene may be based.

THE EXERCISE BLOOD PRESSURE TEST OF MYOCARDIAL EFFICIENCY.*

BY

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THE variations of the blood pressure induced by muscular exercise have been recorded in series of cases by many observers, with a view to establishing a reliable index of myocardial efficiency. Conflicting opinions have been expressed as to the value of the test, for reasons upon which I shall presently touch.

Among those who have recorded their observations one may mention Dr. Strickland Goodall of London, Sir Clifford Allbutt and Dr. Michell of Cambridge, and Drs. Graupner and Baur of Nauheim. Michell found that in athletes the blood pressure varied from 95 to 100 mm. Hg in the early morning to 125 to 130 mm. Hg two hours after hard exercise. Baur found that in normal subjects exercise caused a rise of 5 to 10 mm. Hg, followed by a fall of the same degree. The chief difficulty with which all observers have to contend is that the blood pressure cannot be taken at intervals during natural exercise, because no sensitive instrument would stand the wear and tear. It is true that the blood pressure has been estimated under somewhat unnatural conditions, as in Valsalva's experiment and in Baur's observations on men pedalling on a stationary bicycle with loaded brakes. But for the most part observers have contented themselves with making records of blood pressure before exercise, immediately after exercise, and at intervals after exercise. During the present military work one meets with so many cases of disease or disorder of the heart that the opportunity of comparing the results of the exercise blood pressure test with the results of ordinary clinical examination is one not to be missed.

Accordingly I have applied the test to several cases of "D.A.H." (disordered action of the heart), and I regret that lack of time has prevented me from applying it to a larger number of cases, and more frequently in each individual case. In making my observations I have followed the methods of Dr. Strickland Goodall, with certain modifications. Two grades of exercise have been used: (1) Walking up and down a long corridor several times at a quick pace; (2) running up and down twenty stairs once or twice.

The instrument used was Martin's modification of Riva-Rocci's sphygmomanometer, and the method employed was the combined auditory and tactile—that is, in addition to the usual armlet, a second armlet carrying the chest piece of a stethoscope was applied over the brachial artery. The blood pressure, pulse, and respirations were taken before exercise and at intervals after exercise. The pulse and respirations were counted by Sister Sheridan of my wards while I was estimating the blood pressure.

Dr. Goodall[1] states that for practical purposes the results of his observations may be classified as follows:

1. *Good Reactions.*—Pulse, respirations, and blood pressure all increase and are normal again at the end of three minutes. (From context, "normal" means previous level or rate.) These reactions are characteristic of well trained healthy hearts.

2. *Fair Reactions.*—All cases in which pulse, respirations, and blood pressures go up on exercise, but have not returned to normal at the end of three minutes. Their return is, however, along normal lines.

[*Note.*—The pulse-rate is the one that usually remains raised, and much importance attaches to the time for which the increased frequency is maintained.]

These reactions are characteristic of the physiological but poorly trained or atonic hearts of persons of sedentary occupation. Nicholson, in his book, *Blood Pressure in General Practice*,[2] states: "With cessation of the exercise both blood pressure and pulse will in a short time return to their previous level, the pulse-rate a little before the blood pressure. In myocarditis cases, if mild, there will be an elevation of blood pressure and an acceleration of the pulse-rate, but the blood pressure in a short time will fall below its previous level, while the pulse-rate remains higher longer.

"In some severe cases the blood pressure will fall from the start, the pulse-rate increasing, the blood pressure rising to its previous level only after a long time."

Goodall groups these severe cases of myocarditis under his two remaining types of reaction:

3. *Bad Reactions.*—The blood pressure fails to rise, although the pulse and respiration go up.

4. *Very Bad Reactions.*—Pulse and respirations increase, but the blood pressure actually falls.

He states that "bad" and "very bad" reactions are typical of hearts in which the myocardium has been damaged by inflammation, strain, or degeneration.

I show first on one chart four imaginary observations, illustrating the four types of reaction which have been just mentioned, namely: (1) Good, (2) fair, (3) bad, (4) very bad. If we agree to adopt Goodall's standard, such a chart serves as a rough foot-rule, which can be applied to charts made from our own observations. Goodall does not state the diastolic pressure in his cases, and I infer that he did not employ the auditory method.

So far as I am aware, no very accurate estimation of the diastolic pressure can be made by tactile or visual methods. In my cases I have included the diastolic pressure as a matter of interest. Since the systolic pressure is approximately the intraventricular pressure and the diastolic pressure is the peripheral resistance, the difference between the two is the pulse pressure, that is, the pressure driving the blood on and through the arterioles.

Strasburger found that after exercise the systolic and diastolic pressures stand in no constant relation to one another. But estimation of diastolic pressure is important in at least two ways: (1) Rise of systolic blood pressure may be due to (*a*) increase in systolic output and concomitant increase in tonicity; (*b*) stimulation of vaso-constrictors centre (unfavourable). In the latter case there should be rise of diastolic pressure. (2) When systolic and diastolic pressures approximate, cardiac power is poor.

The great value of the test is obvious, if we can depend upon it to give us accurate, reliable information as to myocardial efficiency. We know that "D.A.H." is a comprehensive term embracing a large variety of disorders of the heart, but I assume that in the main our object is

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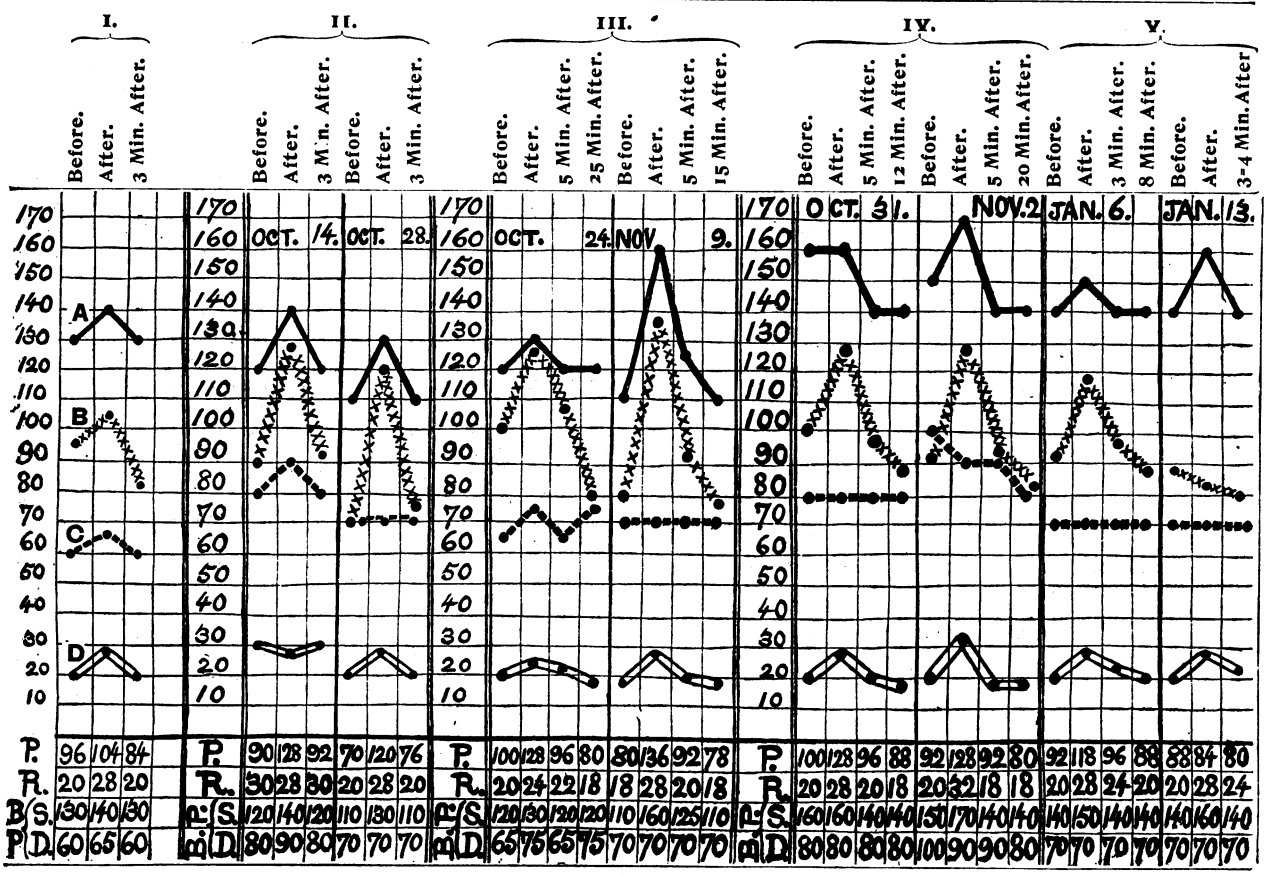

The sign at A denotes the systolic blood pressure; that at B the diastolic blood pressure; that at C the pulse; and that at D the respiration.

to draw a dividing line between cases in which the disorder is purely functional in character and cases in which the disorder results from pathological conditions of the myocardium.

Sir Clifford Allbutt has worked at this problem since the year 1870, and as recently as 1909 he modestly stated that he still approached it with diffidence.[3] This attitude of a very eminent authority is in striking contrast to certain very loose but confident opinions as to diseases and disorders of the heart which have been expressed since the war began.

Sir Clifford Allbutt classifies cases into two main groups:

(*a*) Functional fretfulness of the heart. These are cases in which the action of the heart is disordered by reflex influences from one or more of several organs—the stomach, the brain, the sexual organs, and so forth.

(*b*) Over-stress of the heart. These are cases in which the heart has been pushed beyond the limits of its capacity, and actual strain or damage of the myocardium has resulted. I shall refer to the question of "strain" again presently.

So much for the objective of the test. Turning to some of the actual cases to which I have applied it:

Chart I: Pte. G., aged 23 years, serves as an example of a good reaction. Both systolic and diastolic pressures rose slightly and returned to the original level within three or four minutes. There was a moderate increase in the pulse-rate and then a fall to a rate below that present before exercise. The rate of respiration did not vary greatly.

In my opinion the test was of distinct value as confirmatory evidence of my diagnosis in this case. The patient was sent in as a "V.D.H." (valvular disease of the heart). Having failed to find any sign of valvular disease of the heart either at rest or after muscular exercise, I applied the blood pressure test. The position of the apex beat was somewhat variable, sometimes in the nipple line, at other times within it. It was not displaced outwards by exercise; there was no sign of cardiac or respiratory embarrassment after the test. There seems no doubt that the patient had a nervous, irritable heart, with moderate tachycardia.

Chart II: Pte. T., aged 40 years, is another example of good reaction.

Chart III: Pte. D., aged 19 years, is a fair reaction.

In the case of T. the blood pressure rose and fell to its original level on both occasions within three or four minutes, at the end of which time the pulse-rate was only a few beats above its original rate.

D's. chart is classed as "fair," because, although the reaction was "good" on the first occasion, the return of blood pressure and pulse to their original level was more gradual on the second occasion—that is, a "fair" reaction. Both appeared to be cases of functional nervous disturbance of the heart without evidence of dilatation from strain. In these cases again the test proved itself of value. The patients were twice under my care. On the first occasion they were sent out recommended for graduated exercises.

The exercises were not given, and after some time the men were returned to me. I then applied the test, and, armed with its results, as well as the results of examination of the heart before and after exercise, I had no difficulty in disposing of the cases again.

The results shown in Chart IV, Cpl. M., are not so easily classified; but I should regard the reaction as bad. On both occasions the pulse rate rose and fell as in a good reaction, but the behaviour of the blood pressure was bad. On the first occasion it failed to rise, and indeed fell 20 mm. during the five minutes following exercise. On the second occasion it rose from 150 to 170 mm., and then fell rapidly to 140 mm. Unfortunately, I had not time to follow the progress beyond a period of twenty minutes after exercise. The history of the case was a bad one. The patient, aged 34 years, but looking older, stated that he had suffered from a "dilated heart" in civil life attributed to a sudden physical strain. He was employed in the A.S.C. unloading ships, and was sent home from France complaining of precordial pain, dyspnoea, and palpitation after exertion. The diagnosis on his travelling label was "tachycardia." For some time after admission the position of the apex beat was very variable, at times as much as one inch external to the nipple line. The impulse was diffuse. The pulse-rate was very variable, and at times very frequent. The patient was nervous, restless, and depressed, and complained of a good deal of pain over the precordium. No increase of percussion dullness to the right of the sternum was detected. He had been treated for some time before the tests were applied, and had improved. The apex beat was within the nipple line, and the heart sounds closed both before and after the tests. I regarded the case as one of strain of the heart, and recommended the patient as fit only for S.F. III employments. Possibly physical strain was not the only factor, but the result of the combined factors was apparently definite damage of the myocardium.

Chart V: Pte. J., aged 19 years. This was a D.A.H. case with definite cardiac dilatation. On admission the apex beat was in the fifth left interspace, half an inch external to the nipple line. Impulse was diffuse and forcible. Superficial cardiac dullness extended to the third left interspace in the parasternal line. Transverse cardiac dullness was variable, extending from ¾ in. to 1½ in. to right of sternum at level of the fourth rib. The pulse-rate was very variable, but tachycardia always present. Extra-systoles occurred from time to time. There was a systolic

bruit at the apex, conducted to the left for a short distance. The pulmonary second sound was not notably accentuated; there was no cyanosis. When the test was applied he had improved under rest and treatment. The apex beat was ½ to ¾ in. within the nipple line. The heart sounds were closed, and other physical signs remained the same after as before exercise. There was a very decided nervous element in the case, and I was inclined to regard the dilatation of the heart as caused by persistent irregular tachycardia. The reactions on both occasions would seem to fall into the class of "good" reactions; but one has to remember that the response would probably not have been good to more searching tests. In this case I did not feel justified in applying more severe tests.

Heart Strain.

The Leipzig school—De la Camp, Krauss, Moritz, and their followers—maintain that it is quite impossible to push the healthy heart and great arteries beyond the limits of their reserve by any muscular effort. This may or may not be true of the healthy heart, but it would be absurd to contend that it applies to a heart of which the myocardium has been previously damaged. Even Zuntz and Schumberg, of the German school, recognize "march dilatation of the right heart" in soldiers.

Apropos of dilatation of the right heart, one physical sign which I have found present in at least 40 or 50 per cent. of D.A.H. cases seems significant. The superficial cardiac dullness is extended upwards in the left parasternal, often as far upwards as the upper end of the third left intercostal space. Since almost the whole of the anterior surface of the heart is formed by the right auricle and ventricle, and the right ventricle lies behind the third, fourth, and fifth left intercostal spaces, we can hardly resist the conclusion that this physical sign is produced by dilatation of the right ventricle. When we consider with it the fact that murmurs in D.A.H. cases are so frequently heard in the third, fourth, and fifth interspaces between the nipple line and the sternum, usually close to the sternum, we seem bound to give them careful consideration. It is unjustifiable to dismiss them lightly as "accidental" or "haemic" murmurs. "Disordered action of the heart" is not necessarily a harmless transitory condition.

Captain McCarthy, R.A.M.C., who studied the condition in a number of cases, found that the prognosis was not good.[4] In the majority of cases the patients returned to hospital again and again, until they were invalided out of the service. His impression, formed by following up the history of men invalided, was that many cases ended in valvular disease.

In dealing with D.A.H. cases our prime object is to form as shrewd an estimate as possible of the quality of the muscle fibre with which we are dealing in each individual case. The previous history, therefore, is of great importance, and the rôle played by past attacks of the infectious febrile diseases in causing degeneration of the myocardium should not be forgotten.[5] It is well to bear in mind also Niemeyer's dictum that there are probably many forms of degeneration of the myocardium which cannot be detected by the microscope.

Even those with the greatest experience of "heart strain" have to content themselves with hypotheses as to its pathology. Sir Clifford Allbutt suggests that a molecular change, probably not to be detected by the microscope, may occur in the cardiac muscle fibre leading to diminished resilience.

Size of Heart during Exercise.

In support of the German school's theory that the healthy heart cannot be dilated by muscular exercise, radiographers now maintain that the heart does not increase in size during exercise; on the contrary, the right ventricle is not dilated, and the left ventricle actually diminishes in size.

After reading pages of controversy on the subject one feels that there is little, if any, ground for contention. Physiologists have never maintained that the heart dilates and remains dilated throughout muscular exercise. They tell us that during the earliest stages, before relaxation of the arterioles occurs, the right heart takes the strain off the left ventricle by accommodating an increased output of venous blood from the muscles. But in a well-trained, "hardened" athlete or soldier this is only a passing phase. The increased volume of blood is dealt with by (*a*) increased alveolar capacity of the lungs; (*b*) development of the thoracic muscles; (*c*) by fall of peripheral resistance, which enables the blood to flow more easily through the left ventricle. Leonard Hill found that arterial pressures exceed ordinary levels for the first ten or fifteen minutes of exercise; then, as the periphery opened out, they fell.

In short, there is no need to insist on either great hypertrophy of the left ventricle or perilous dilatation of the right ventricle during exercise. Both speed and endurance would seem to depend not more on hypertrophy and increased capacity than on efficient correlation of the many mechanisms devised to assist the heart and to diminish its work. In other words, men do not run with their hearts alone, but with their hearts, lungs, thoracic muscles, and peripheral vessels, especially those of the skin.

Evidence Against the Value of the Exercise Blood Pressure Test.

Hirschfelder, after discussing the work of Graupner and Baur, advances the following objections to the test:[6]

1. That the blood pressure in trained athletes falls during mild exercise, exactly as it does in broken compensation; also that it falls when the "second wind" is acquired and while the person's functional power is increasing rather than decreasing.
2. The greatest rises of blood pressure occur in old and feeble persons, whom the exercise brings near to the border line of cardiac overstrain.
3. In persons in whom the blood pressure falls as a result of the test exercise, the general symptoms, respiratory distress, tachycardia, arrhythmia, etc., are more than sufficient evidence that the patient's strength has been overtaxed. These simple signs are more delicate indices and less ambiguous than the changes in blood pressure.

Following De la Camp, Schott, Moritz and others, he concludes:

The only true criterion of cardiac efficiency is whether a given strain causes it (the heart) to diminish in size (increase in tonicity = stimulation) or to dilate (decrease in tonicity = overstrain).

For my part I am already convinced that none of these objections should induce us to abandon the test, which seems distinctly valuable in two directions: (1) as confirmatory evidence of the results of ordinary physical examination in some cases; (2) as an additional test in other cases in which the diagnosis between functional disorder and organic disease of the myocardium is doubtful.

It is noteworthy that even Hirschfelder, after all his destructive criticism, commits himself to the following statement:

This does not mean that the exercise tests are unimportant. On the contrary, they are of the greatest possible value; and no change in the patient's mode of life during convalescence or during after-life should be undertaken without them.

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PULMONARY FAT EMBOLISM AND ITS RELATION TO TRAUMATIC SHOCK.

BY

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ON my arrival at a casualty clearing station in France last year I was greatly impressed by the type of cases of so-called shock, which closely resembled cases of pulmonary fat embolism I had seen with Bissell at the Mayo clinic. During the last ten months I have been able to investigate a considerable number of cases whose clinical condition was assimilated to "shock."

It is well known to those who have had experience in the resuscitation wards in forward areas that there is a type of wounded admitted characterized by the following features:

Cyanosis, moderate varying to deep.
Pulse small, easily compressible, and increased in frequency.
Breathing sometimes laboured and increased in rate.
Extremities cold.
Delirium of varying degree.

It will have been noticed also that there is no appreciable or sustained response to measures of resuscitation—