Such measurements are complete, but a thorough knowledge is not thus attained of the circulatory phenomena involved in any disease when such observations are carefully made and carefully recorded from day to day.

The feature to be studied in the circulation in health and in disease is the power of the heart in conjunction with changes in the peripheral blood field to adapt itself quickly and efficiently to extra strain. In health every one is constantly making calls on the power of the heart and peripheral field to adjust themselves either to extra strain or to diminished strain. Consequently, although advance is made when the scope of the measurements of the clinicians is broadened from isolated measurements of systolic pressure and pulse-rate to that of systolic, diastolic, pulse pressure range, rate of heart beat, rate of respiratory rhythm, these measurements are still measurements made under the uniform conditions of repose on a bed in a hospital ward.

Physiologists appreciating this point have published observations of blood pressure before and after muscular exercise in healthy subjects. Thus Pombrey has made a series of interesting observations. Records have been taken of blood pressure before and after running and before and after the lifting of heavy weights. Such observations, though useful, are also incomplete, because they do little more than serve to show what changes have taken place in the blood pressure after the exercise is over. They vary with the power of the circulatory system to adapt itself quickly to the change from activity to repose. As all measurements take time to perform and as the circulatory system in healthy individuals has great power of rapid adaptation, the conclusions drawn from the measurements are apt to be vitiated.

Consequently if a satisfactory knowledge of the heart and peripheral circulatory system in the human subject in health and disease is to be gained, it is necessary to examine and record the changes in systolic, in diastolic, pulse pressure range, rate of heart beat, rate of respiratory rhythm, during the strain thrown on the heart by exercise, not after it is over. The systolic pressure can be estimated during exercise either by the auditory or the tactile index, but the diastolic index is estimated by the auditory index alone. Consequently it is best, perhaps, to adhere to the auditory index for both measurements. Previous to the outbreak of war I had found in Aberdeen that it was possible to get satisfactory observations of systolic pressure, diastolic pressure, rate of heart beat, and rate of respiratory rhythm in a series of medical students who kindly volunteered their services. As the auditory method is used the work done must be such that the arms of the individual tested should be reasonably rigid and that the exercise should produce as little noise as possible. The subject was placed on his back on a polished table and the exercise consisted in rhythmically drawing up his feet and legs as in swimming on the back. The mildness of this exercise depends on the length of time that it is kept up.

It was thus possible to draw graphs of the systolic and the diastolic pressure, with observations on the rate of the heart beat and the rate of respiratory rhythm during the exercise. It is true that the observations of systolic and of diastolic pressure cannot be made simultaneously, especially with increased rate of heart beat. But when such observations are numerous, and are plotted alternately over a considerable period, the importance of taking them simultaneously is practically *nil*.

Such graphs give a true picture of the response of the heart and of the peripheral system to a given amount of work over a given period of time. We can trace how the circulation as a whole adapts itself to the changed conditions.

It is also possible to examine the circulatory phenomena during exercise in the erect posture by the auditory method. The exercise employed was the working of a heavy but silent lathe with one foot. Such graphs enable us to see how the heart adapts itself to gravity and to exercise simultaneously, and from such graphs the efficiency of the mutual adjustments of the heart and of the vasomotor system can be tested.

The ranges of blood pressure, both systolic and diastolic, in healthy and in unhealthy subjects vary greatly. It is obvious, then, that the response to a given amount of work of normal adults with a blood pressure of, say, 130 systolic, 75 diastolic, and a rate of heart beat, say, 78, should be investigated. Having established the normal graphs, the investigation should be carried on cautiously to people

with abnormal systolic and diastolic pressures. By so doing we may learn to appreciate what is the real significance of any abnormal blood pressure range.

Translating these problems into more concrete form, we may ask how a subject, whose diastolic pressure is originally high, fares when tackling a given amount of work. We know that, theoretically at least, he starts with the disadvantage that a considerable amount of cardiac energy in excess of the normal has to be spent in opening the aortic valve. Or we may take the case of aortic incompetence with initial high systolic pressure and initial low diastolic pressure, and ask what series of blood pressure changes take place during exercise. Does such a case develop during exercise a high diastolic pressure in spite of incompetent valves? I put these questions simply to show that in the whole of the literature of blood pressure we have no guide to the true significance of blood pressure ranges which depart from the normal. We have never isolated these departures from the normal and tested them against the performance of a given carefully graduated amount of work. We do not know how Nature has adapted both the heart and the peripheral circulatory system to overcome initial defects. We may state that breathlessness on exertion is a cardinal symptom, but has the case developed this breathlessness on exertion because the heart has failed or because the adjustments of his peripheral circulatory system can make are inadequate?

Enough has been said to show what problems await solution. But by the method of graphs taken during exercise, with the exercise carefully graduated so as not to be injurious in diseased conditions, we may hope to learn something of what is meant by vague terms such as "circulatory equilibrium is restored."

It should be clearly understood that until we know the significance of various levels of pressure, systolic and diastolic, with various rates of heart beat and respiratory rhythm, a mere chronicling of measurements in countless clinical lectures is without significance.

I have carefully refrained from stating what were the results of the investigation made by this method on healthy students because the war has prevented me from checking and rechecking the observations. Enough was accomplished to show me that the method was useful, and that further experimental methods could be applied to it, such as varying the mixture breathed and the temperature of the surroundings. Consequently the influence of such factors as are involved in ventilation problems could be examined.

SEPTIC ENDOCARDITIS: INTRAVENOUS INJECTION OF EUSOL: RECOVERY.

BY

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THE following case, in which recovery from what seemed to be a hopeless condition followed the intravenous injection of eusol, is worthy of record.

A girl of 13 developed erysipelas of the right foot on December 17th, which spread halfway up the shin and disappeared in a week.

On January 6th a systolic murmur could be heard over the precordium, which was considered to be pericardial in origin; it was accompanied by slight pain. Under treatment with sodium salicylate and bromide, the pain and murmur disappeared by January 25th, and the patient was apparently making an uneventful recovery.

On January 28th she had a severe rigor, with sudden dyspnoea and intense precordial pain, accompanied by hacking cough, with a small quantity of sticky mucus. Scattered crepitations were to be heard over both sides of the chest at the back. The temperature was 102°, and the pulse 166. A diagnosis of ulcerative endocarditis with pulmonary embolus was made.

On January 29th the temperature was 103°, the pulse 146, and she had a slight rigor; 25 c.cm. B. and W. antistreptococcal serum (ulcerative endocarditis) was given hypodermically. The temperature fell to normal within twelve hours, and her general condition was much improved.

The improvement was maintained for a week, but on February 8th the pulse and temperature began to rise, and her general condition was not at all good.

On February 11th there was a rigor; the temperature was 103°, the pulse 148, and there were pain, tenderness, and swelling of the left elbow. A profuse petechial septic rash appeared on the legs and rapidly spread over the body, and a bed sore formed.

On February 12th the serum was repeated (50 c.cm.).

On February 13th, 14th, and 15th, the temperature was

normal but the pulse was rapid and dicrotic, and the general condition growing progressively worse. The skin was smothered with the septic rash.

On February 14th a large subcutaneous haemorrhage appeared in the left iliac region, possibly caused by an embolus which lodged on February 11th at the time of the rigor. Vulvitis also developed.

Dr. Hebblethwaite saw her in consultation on February 15th. The iliac haemorrhage then seemed to be breaking down. The patient was very bad and appeared to be in a hopeless condition. We considered that she was suffering from a virulent infection of the blood stream and that vaccine could not possibly do any good. As a last resort we decided to give her eusol intravenously as used by Captain John Fraser, R.A.M.C., and Captain H. J. Bates, R.A.M.C., for the toxæmia of gas gangrene, as reported in the BRITISH MEDICAL JOURNAL of January 15th, 1916.

On February 16th 40 c.cm. of eusol were given intravenously preceded by 300 c.cm. of normal saline. Her condition at the time of the injection was much worse than on the preceding day. She was semi-delirious, the pulse was weak and thready; there were sordes on the lips, and she was apparently dying.

After the injection she perspired freely, and an hour later she had another rigor, but that night she slept well without a sleeping draught for the first time for three nights. The next day the pulse was much improved in quality, and her general condition was distinctly better. She steadily improved from that time on; by February 20th the bed sore was almost healed, the vulvitis had gone, and the rash was rapidly fading. She was sleeping well, and her appetite was returning.

On February 24th the iliac haemorrhage broke down, leaving an ulcer which was unresponsive to boric fomentations but cleared up after local treatment with eusol. The rest of her recovery was uneventful except for occasional slight rises of temperature.

She came to see me on June 15th, when she was apparently well except for some rapidity of the pulse and anaemia.

No blood culture was made, so the diagnosis was not proved, but clinically the case was typical of an acute sepsis of the blood stream.

The action of the serum was interesting. The first dose seemed to do a great deal of good, and apparently checked the course of the disease for some days. The second dose brought the temperature down, but did not improve her condition; in fact, she got rapidly worse.

At the time of the intravenous injection she had numerous crepitations over both lungs at the back; they did not seem to be increased by the injection, and disappeared in a few days. She was getting progressively and rapidly worse up to the time of the injection, and was apparently moribund when it was given. She improved rapidly and steadily after it, and I have no doubt whatever that it saved her life.

Memoranda:

MEDICAL, SURGICAL, OBSTETRICAL.

"SLING ATROPHY" AND KINDRED DISABILITIES.

IN the EPITOME OF CURRENT MEDICAL LITERATURE (June 10th) a note is published on "Sling atrophy of the arm" by Richard and Stern. I would like to call attention to a similar condition in the lower limb.

Paralysis of the tibialis anticus and of the everters of the foot is frequently observed after some injury, such as a "crush" to the ankle, which has not seriously injured either the muscles or their nerve supply. On examination a month after the injury there may be no pain and all passive movements may be reasonably free. Although failure to support the foot in a dorsiflexed and everted position may be a contributing cause, the paralysis or paresis may occur even when this precaution has been observed. The lack of voluntary power seems to be due to some peculiar blending of physical and mental causes, the exact pathology being obscure.

The electrical reactions of the muscles concerned are, after this lapse of time, normal, or nearly so. The patient should be shown that all the movements of the foot can be produced electrically, and encouraged to try to produce them himself. These efforts on his part should synchronize with the artificial stimulus, the strength of which must be gradually reduced as his control increases. Daily treatment for two to three weeks will generally restore voluntary power. The exceptions are patients with hysterical tendencies, with regard to whom prognosis should always be guarded. In general, however, a speedy and complete recovery may be looked for in the absence of any demonstrable physical lesion; but some patients, unless specially

urged and encouraged, will not make any effort to move the foot even though a relaxation splint, massage, and electricity may have perfectly restored the muscles from a mechanical point of view.

Once a state of physical normality has been reached—which will be in from two to eight weeks, according to the severity of the original injury—continuance of electrotherapy, etc., will do positive harm unless there is definite sign of returning voluntary power. The patient's re-education must be taken in hand with considerable vigour. He should be allowed to walk about with an elastic support to his boot to prevent foot drop. It will generally be found, on holding the foot in a posture of extreme dorsiflexion, that he can cause the tendon of the tibialis anticus to tauten and slacken, even though he cannot at all hold his foot in position. In very bad cases even this movement may be lacking; it must then be patiently elicited. This is best done by holding both feet in the same position, and getting the patient to try to move both tendons in unison. Tapping the muscle lightly with the finger-tip will often give the required impetus. By some means or another this very modest accomplishment must be acquired if the case is to get well, for it is the starting point of all else. The movement should be performed rhythmically for some minutes several times a day, care being taken, however, to avoid fatigue. Much patience is necessary; any manifestation of irritability on the part of the teacher may be fatal. The next step is to get the patient to hold the foot momentarily in position while the supporting hand is withdrawn. Finally, active dorsiflexion is essayed, but this should not be until the patient has learned to hold his foot in position for two to three minutes without difficulty.

The above procedure is seldom needed in early cases. If called for, it is in them nearly always successful. When, however, a patient has been treated for many months by elaborate physico-therapeutic methods, he becomes unconsciously, if not consciously, imbued with the idea that he is incurable. Re-education on the lines above described can now alone do any good, and his restoration is likely to be a matter of months rather than weeks. Moreover, it is only possible at all provided that his confidence can be gained, and that he is willing to face cheerfully the probably long course of treatment. Unfortunately this type of patient is generally, and not unnaturally, anxious to escape from the hands of the doctors; and if a man so affected, who has already spent much time in hospitals, has set his heart on getting out of the army, it is quite useless to waste time on the case.

Hypnotism is sometimes of great value, but six months' unsuccessful treatment may produce a fixed idea, even in a man both mentally and physically robust, which requires for its removal a depth of hypnosis only occasionally obtained.

London, W.

FRANCIS HERNAMAN-JOHNSON.

TRISMUS DURING SERUM SICKNESS.

IN the BRITISH MEDICAL JOURNAL of August 12th, 1916, there is an account of this condition by Captain Bolt, R.A.M.C. The symptoms are so disquieting to the medical man in charge of such a case that I record a somewhat similar experience in the hope that further records may show to what extent such occurrences are frequent.

About two years ago I had to treat a case of puerperal fever due, I believe, to severe periodontal disease. The confinement was terminated by instruments. On the next day the temperature began to rise, and reached 104° F. on the third and fourth days with one or more rigors; 10 c.cm. of polyvalent antistreptococcic serum were given, and the uterus explored. A portion of placenta was found, and a swab taken from the interior of the uterus, which yielded on cultivation a pure growth of streptococci from which a vaccine was prepared.

Twenty more c.cm. of serum were administered with the vaccine with most satisfactory results, when a painful condition of the muscles of the neck supervened, with difficulty in opening the mouth. This disagreeable symptom increased till only the spout of a feeder could enter the mouth. There was no rash, or other symptom of serum poisoning, and in forty-eight hours the spasm of the jaw disappeared, during which time 5-grain doses of chloroform had been given every four hours.

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