On the technology of mechano-therapy and resistance movements in the treatment of heart disease / by Thomas Stretch Dowse.

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ON THE TECHNOLOGY OF

MECHANO-THERAPY

AND RESISTANCE MOVEMENTS

IN THE

TREATMENT OF HEART DISEASE.

BY

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PREFACE.

In the firm belief that Massage and Resistance Movements are of great value in giving tone to the Cardiac Muscle, and having for some years studied the effects of Massage upon the heart and circulation, I have been induced to write this little *brochure* upon the subject, knowing that it possesses a practical significance.

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Mechano-Therapy and Resistance Movements in the Treatment of Heart Disease.

IT is only within the last few years that massage and properly constituted exercises have been fully recognized and adopted in this country as a form of treatment for heart disease, particularly in those cases known as heart failure, and heart incompetence. When massage is combined with brine effervescing baths, and resistant gymnastic exercises, it constitutes what is now known as the Nauheim or Schott treatment, which is, in fact, a speciality of Nauheim, with which most physicians are acquainted, and it is an unquestionable fact that thousands of patients visit this small German town annually, suffering from all kinds of heart disease, organic as well as functional, and derive a very considerable amount of benefit, to an extent which they are unable to obtain by other means. From the published reports of physicians who have been to Nauheim and witnessed this treatment there seems to be a general consensus of opinion in its favour; some attribute the results to the saline baths in producing dilatation of the arterioles, and so reducing blood pressure; others, that the results brought about are due to the action of the minute particles of carbonic acid upon the fine peripheral terminations of the surface nerves; whilst others, again, believe that by the impulse of cold there is produced an increase of intra-cardiac pressure by the contraction of the cutaneous vessels acting as an incentive to increased activity of the cardiac muscle. From my own personal experience at Nauheim, I am convinced that the effervescent flowing brine bath (Sprudelstrom-bad), has a most marked effect upon the heart and circulation: so greatly is this the case, that I know of no other bath in the world which can be compared to it as a tonic to the cardiac muscle, and in my opinion these very marked and decided effects are due not to one factor alone but to a combination of factors which exist in this most wonderful bath, truly a peculiarity of Nauheim. Dr. Groedel, one of the resident physicians at Nauheim, in writing of this bath says (without exaggeration): "The brine, which is unusually rich in carbonic acid, flowing as it does continually through the bath, must have a powerfully stimulating effect on the general nervous system which operates as

a tonic on all the nervous organs, including the innervation of the heart, in a much milder manner, though certainly not less powerfully than the cold water baths. Artificial carbonic acid baths, which were first recommended by Nauheim physicians, have yielded good results, but at Nauheim the natural baths can be graduated most exactly, and the bathing treatment which was formerly limited to weak carbonic acid baths, and then only applied to a certain number of those patients suffering from heart disease, has been brought to such a state of perfection and exactness as to be found in no other place." From my knowledge of the Nauheim baths, I can most emphatically endorse these statements of Dr. Groedel. I now leave any further notice of Nauheim and its baths, with all the conflicting theories therewith associated, as my prime object is to show, and as far as I can to illustrate, the best modes of massage, and the resistant exercises which can be used in the treatment of Heart Failure. These are not peculiar to Nauheim in any sense whatever, for I have taught and practised them myself for many years, and I do not hesitate to say, that I am a firm believer in their usefulness and efficiency. To Sir T. Grainger Stewart, and his assistants, we are deeply indebted for the great interest which they have taken in carrying out this treatment in the Royal Infirmary at Edinburgh, and in a paper read by him, at the meeting of the British Medical Association at Carlisle, to open a discussion "On the Treatment of Cardiac Failure," he stated that he had fully satisfied himself upon the following points, in the following words:—

1.—That in the great majority of cases of cardiac dilatation, the area of cardiac dulness diminishes perceptibly during each administration of massage.

2.—That the character of the cardiac sounds, and the rhythm and strength of the pulse correspondingly improve.

3.—That the patients usually experience a sensation of comfort and feel the better for the treatment.

4.—That on one or two occasions I have seen the manipulations produce the opposite effects in all these particulars, apparently because the heart was feeble, and the patient fatigued at the time of application.

5.—That although the immediate favourable effects pass off in a few hours, they frequently do not pass off completely, for I have often found the line of cardiac dulness within that with which we had started at the previous séances.

6.—That repeated applications of massage bring about a permanent diminution of the area of dulness, with improvement of pulse and of the patient's sensations.

7.—I have seen a case in which the Schott movements produced a deleterious effect, rendering the heart more irregular and intermittent, treated by this method on the following day with the

most striking benefit. It appeared that the patient was not sufficiently well to bear the active movements, but benefited greatly by the passive.

Evidence of this kind from so distinguished an observer as Sir Grainger Stewart, which is the outcome of an extensive and prolonged experience, fully justifies, and in fact demands the careful and thoughtful consideration of every physician interested in the treatment of heart failure. The Nauheim treatment has certainly led the clinicist to study and note the beneficial results which are obtained by stimulating the skeletal muscles, and their nervous and vascular supply in developing the increase of tone and power, as well as regularity of rhythm in the muscle of the heart, and so insuring its normal and co-relative activity, thus enabling it to adapt itself by increased nutrition, and even by hypertrophy to combat and overcome resistances which probably its own intrinsic failure had created, or which had been created by pathological changes, either in the nervous or vascular systems, or in both combined. To recognize the nature of these affinities is a very simple matter, it is in fact merely an exposition of the primitive laws of physics and physiology, so far as they refer to the mechanics of the heart and circulation. To embrace, however, every phase of failure of the heart from the sensori-motor and psycho-motor aspects, is a problem of great complexity, and is altogether beyond the range of these observations.

Before discussing the technology of the subject, I may perhaps be pardoned if I draw the reader's attention to some elementary physiological facts, *which are of prime practical importance to a right understanding of heart failure, and its treatment by mechanical methods.*

THE VASCULAR SYSTEM,

of which the heart may be looked upon as the centre, forms a closed circuit of elastic tubes through which the blood circulates, and with which it is continuous; or, in the words of Gaskell, "The heart may be regarded as a modified longitudinal bloodvessel, the ganglion cells remaining in their old situations in the less modified parts of the tube, and acting as trophic agents for the post ganglionic nerve fibres, especially of the vagus nerve." It is the duty of the heart, through the contractile power of the ventricles, to drive the blood into the arteries, from the arteries into the capillaries, and from the capillaries into the veins; from the veins it finally returns into the heart. There are two circuits, viz., the systemic or greater circuit, which conveys the blood through the whole system to all the tissues of the body, and the pulmonary or lesser circuit, which conveys the blood through the lungs. Thus the heart forms a

pump, inasmuch that it has : (*a*,) driving power; (*b*,) suction power; (*c*,) valves. There is a *resistance* to the *flow* of blood in consequence of the friction between the blood and the vessel wall in the small arteries, and to a lesser extent in the capillaries (*peripheral resistance*). Owing to the yielding nature of the walls of the veins as compared with the walls of the arteries, it is found that a small rise of pressure will increase their capacity considerably, but the injection of a small quantity of fluid on the arterial side will bring about a large rise of pressure. Thus it is found that in the veins the pressure is very low, barely sufficient to send the blood onwards towards the heart, *muscular movements and the movements of respiration helping to this result.* Normally the heart is at work for about nine hours of the twenty-four, leaving about fifteen hours at which it is at rest. The mechanism of the heart is summarized in the following propositions. During systole the ventricles contract and empty themselves into the *pulmonary artery* and *aorta* ; the *semilunar valves* of these vessels are open, the *auriculo-ventricular* valves are shut, *the first sound is produced.* During diastole the ventricles are relaxed, the *semilunar valves* of the *pulmonary artery* and *aorta* are closed, the *auriculo-ventricular* valves are open, and the blood is flowing from auricles to ventricles. Just at the end of diastole the auricles contract. The second sound is produced at the beginning of diastole. At each systole the volume of the heart is diminished. The *power of adaptation of the heart* to changing and changed conditions, both in its own intrinsic mechanism, and in its environment, may be looked upon as one of its essential endowments, and when it is unable to respond to physiological resistances, it is said to fail; it has, in plain words, something to do which it is unable to accomplish, the result being that its action is laboured, and its muscle is subjected to *strain* and *tension*, which, if continued, gives rise to dilatation and to hypertrophy of the walls forming its cavities. *The reserve power of the heart* and its response to stimulation under even trying and adverse circumstances is one of the marked features of its organization. The heart's force on the *one side* and the peripheral resistance on *the other*, are the main factors in the production of arterial *blood pressure*, which will obviously vary with variation of these factors; that is, *Pressure will be greater with greater heart's force or with greater peripheral resistance, and less with less heart's force or with less peripheral resistance.* Associated with ventricular contraction is a necessary expenditure of energy to overcome the resistance presented by the blood pressure in the arterioles and the capillaries, so that any increase in these resistances must lead to increased work on the part of the heart, and any inadequacy in the pumping power of the heart will be recognized by a fall of arterial pressure, as well as to a rise of pressure in the large venous trunks near the heart.

The heart beats more frequently and with greater impulse under *violent exertion*, and the blood pressure is temporarily raised; on the other hand, a *sudden shock* or a *strong emotion* or stimulation of the vagus, weakens or arrests the action of the heart when the blood pressure is temporarily diminished.

When from any cause the *vaso-motor centre* in the medulla is *stimulated*, the muscular arterioles *contract*, and *narrow* the outlet from the arterial system so that the peripheral resistance is *increased*, blood pressure is *raised*, and *less* blood will flow through the constricted outlet. If, however, the *vaso-motor* centre is *inhibited* or *destroyed*, the muscular arterioles *relax* and *widen* the arterial outlet, blood pressure *falls*, and more blood will flow through the *dilated* vessels. A weak and failing heart with relaxed arterioles and low blood pressure is the invariable accompaniment of great prostration and dissolution. Thus it is found that the immediate effects of increased or diminished blood pressure are always an increase or diminution of blood flow. Functional activities of parts, say, for instance, a gland during secretion, a muscle during contraction, the brain during mental exertion, and the digestive system during digestion, require and receive more blood than when they are at rest, their arterioles dilate and the blood-flow through them is increased.

The influence of the force of gravity on the circulation of the blood has some practical and physiological bearings of great clinical interest and importance in relation to Heart Failure, and for the substance of the following observations I am indebted to the recently delivered lectures of Dr. Leonard Hill, at the Royal College of Surgeons, "On the Physiology and Pathology of the Cerebral Circulation." He says, "The physician and the surgeon daily observe the effect of the position of the body upon the rate of the pulse, the sounds of the heart, diseases of the heart and lungs, hypostatic pneumonia, varicocele, erectile tumours, piles, varicose veins. But on turning to the text-books of physiology, nothing is to be found within their pages upon so important a theme, and on seeking still further into the physiological journals and archives, few and imperfect are the researches there chronicled." One of the earliest observers was Piorry, the distinguished French physician, who insisted on separating *cerebral syncope* from *cardiac syncope*. "In *cerebral syncope*," he writes, "the heart continues to beat, but the beats have not force enough to overcome the resistance which is given by gravity." Therefore the activity of the brain is suspended. If the force of gravity is made to aid the heart in propelling blood to the brain, the syncope will cease. Piorry observed several cases bearing on this point. In one instance he was suddenly called to a patient who had lost consciousness, the respiration was rare and stertorous, sensibility was abolished, the pulse very feeble, the heart very

weak and irregular, and the face pale. The patient had been supported by his friends in the sitting posture for fifteen minutes. Piorry refused to bleed the patient, and laid him down horizontally; immediately his eyes opened, respiration was accelerated, the colour came back to his cheeks, and in three minutes all the unfavourable symptoms had disappeared. Piorry was summoned to another patient, who had been trampled upon in the belly by a horse. He was found supported by his friends in the sitting posture, and almost dead. Piorry immediately placed him horizontally, and the patient at once recovered. After Piorry's departure the patient insisted upon taking his seat in his carriage; on doing so he immediately became unconscious and died. "It is in consequence of gravity," writes Piorry, "that when the arms are held down the veins swell and the capillaries are filled, and that the reverse occurs when the arms are held up, that varicoceles enlarge on standing up, and diminish in the horizontal, and that the head and face redden when held down. It is in consequence of gravity that pneumonia invades the posterior border of the lung when the patient lies on his back, and for the same reason if the patient for a length of time be laid upon his face, the pneumonia appears in the anterior border of the lung." Dr. Leonard Hill, from a series of experiments on animals, proves and demonstrates most conclusively the great importance of the position of the body in the methods of treatment employed in medicine and surgery, and which have an important bearing on the mechanotherapy of heart disease, and these experiments above all point to the necessity in cases of syncope, shock, hæmorrhage and chloroform poisoning, of maintaining the cerebral circulation and filling the heart by elevating or pressing the abdomen.

Waller, in writing of the local variations of the blood flow, instances the area governed by the splanchnic nerves, *i.e.* the intestinal vessels, which is of more than passing importance. He says, "If a contraction occurs of the splanchnic area the blood pressure of that area rises, the general blood pressure shares in that rise of pressure, less blood passes through the splanchnic area, and more blood passes through the remainder of the system; or when a dilatation occurs of the splanchnic area, blood pressure falls in that area, and elsewhere throughout the body, more blood passes through the splanchnic area, less blood passes through the system. This last series of effects is indeed precisely what takes place after every copious meal; blood is then diverted to the intestinal vessels, there is less blood than usual in the remainder of the system, a feeling of chilliness and a disinclination to exertion, mental or physical, are the tokens that much blood is engaged in visceral action, and cannot be spared to other parts. Or if the disinclination be overcome, if by forced exertion blood be called to the brain or to the

limbs, then the visceral blood flow is made insufficient, and digestion is disturbed."

That the influence of gravity is brought to bear in ordinary emotional syncope, from the success of lowering the patient's head between the knees, is well known. Dr. Hill says, "It therefore seems legitimate to suggest that ordinary emotional syncope is produced by sudden and temporary inhibition of the *vaso-motor centre*, caused by some painful and powerful sensory stimulation. Asthenic individuals with the least power of compensation would be most prone to syncope. This theory of syncope can be easily tested on patients by the results obtained on firmly pressing or strapping the abdomen.

Salathé suggested that patients who had lain long in bed lose the power of adapting themselves to change of position, and become like quadrupeds, and hence the faintness, dizziness, and danger of syncope which occurs during convalescence when the patient first rises from bed. *Compensation for gravity is the clinical key to the condition of the vaso-motor mechanism.*

The cause of shock may, I believe, be sought entirely in vaso-motor paralysis, either central or peripheral. A state of shock arises entirely from the fall of blood pressure, and consequent anæmia of the central nervous system. Secondarily, death results when the arterial pressure becomes insufficient to drive the blood to the respiratory centre. Such a state of shock can be rapidly produced in animals by one method only, and that is—with the aid of gravity by complete splanchnic paralysis. When this state of shock exists, the respiratory and the vaso-motor centres are failing on account of the cerebral anæmia and Cheyne-Stokes respiration, and Traube-Hering curves of blood pressure become common. In this state and even after cessation of respiration *compression of the abdomen* will raise the blood pressure and restore the respiratory centre to activity.

The common practice of wearing abdominal belts for weakness, and the application of binders after parturition, find a physiological explanation in the results of this research. Roy and Adami have suggested that the almost universal practice of wearing waistbelts and stays, is due to the fact that compression of the abdomen increases the output of the heart and the blood supply to the brain and muscles."

Cases are occasionally recorded of patients, some of whom lose their memory in the standing position and regain it in recumbency; others can only do mental work when in the horizontal position, and others suddenly are at a loss for memory when attempting to address a public meeting.

Some physiologists maintain that under no circumstances are the ventricles of the heart completely emptied by their contraction, and Prof. Roy appears to have shown that the residual

quantity of blood is a varying factor, dependent (1,) on the resistance to be overcome in the arteries, and (2,) on the diastolic filling of the ventricles, and, as pointed out by Dr. Starling, there is a constant increase in the volume of the heart whenever there is a rise of arterial pressure, or whenever by *pressure* on the abdomen, or injection of normal saline, or defibrinated blood into the circulation, a rise of venous pressure is produced, with increased diastolic inflow into the ventricles. This increased diastolic inflow in all probability leads to increased *tension* of the cardiac muscle, and to a more complete emptying of the ventricles (ventricular contraction), and it is quite possible that massage and the Nauheim treatment tend to bring about this result, and moreover it is also possible that increased tensile action may lead to increased katabolism and augmentation of energy. On the other hand, Dr. Waller maintains that the *normally* acting ventricle is completely emptied at each contraction, and that *abortive* or incomplete contractions are *abnormal.* The Schott treatment when applied to hearts with failing compensation gives to the muscle increased power of contraction, and greater adequacy to contract upon its contents and so lessen its dimensions.

Dr. Starling says, "The energy of the ventricular contraction is expended in two ways: Firstly, in forcing a certain amount of blood into the already distended aorta, against the resistance presented by the arterial blood-pressure, which itself is directly conditioned by the resistance in arterioles and capillaries; and secondly, in imparting to the mass of blood so thrown out a certain velocity. Thus the energy of the muscular contraction is converted partly into potential energy in the form of increased distension of the arterial wall, and partly into the kinetic energy represented by the momentum of the moving column of blood. The work done at each beat may be calculated from the formula:—

$W = w\,R + \frac{wv^2}{2g}$ where W stands for work, w for the weight of blood expelled at each contraction, R is the arterial resistance or pressure, and v is the velocity of the blood at the root of the aorta. In this equation $w\,R$ is the work done in overcoming the resistance, and $\frac{wv^2}{2g}$ is the energy expended on imparting a certain velocity to the blood. It will be seen that the energy expended in the second manner is almost negligeable as compared with that spent on distending the arterial wall, and thus on keeping up the mean arterial blood pressure. Thus, if we take the ordinarily accepted figures of 50 grms. of blood for the output from the left ventricle at each contraction, and half a metre per second as the velocity of the blood in the aorta during systole, and 150 mm.

Hg as the pressure in the aorta, $w\ R$ = 102 gram. metres of work, and $\frac{wv^2}{2g}$ = 0·64 gram metres. Even if the velocity of the blood is quadrupled, as may occur after production *of hydræmic plethora*, this latter amount will only be increased sixteen times, and so will not nearly approach $w\ R$. We may, therefore, neglect the velocity factor in considering pathological changes in the work thrown upon the heart. Any important increase in the work done by the heart can only be conditioned by an increase in one or both of the other two factors—viz., w and R—the amount of blood to be expelled at each stroke, and the resistance offered by the pressure obtaining in the arteries, or caused by any morbid narrowing of any of the orifices of the heart.

In almost all cases of heart disease there is an increase in one or both of these factors. Thus in the case which can be most easily imitated experimentally—viz., stenosis of the aorta—R is largely increased. On the other hand, in pure aortic regurgitation, R may be normal or slightly diminished. During each diastole, however, the ventricle is receiving blood from both sides—viz., from the auricles as well as from the aorta. If compensation occurs, the heart expels almost all the excess of blood which it has received, so that there is a large increase in the factor w. If, as is so frequently the case, stenosis is associated with incompetent valves, both w and R are increased, with a corresponding rise in the work thrown on the ventricular muscle."

In order to have a fair and comprehensive idea of the value of mechanical aids in the treatment of heart disease, and in order to graduate the strength of our modes of treatment according to the requirements and the necessities of each particular case (for in this the success of the treatment depends) we must be familiar with the compensatory processes and mechanisms which are brought into play in the working of the heart. These were very ably and clearly discussed in the Arris and Gale lectures, delivered by Dr. Ernest H. Starling, at the Royal College of Surgeons, "On Some Points in the Pathology of Heart Disease." The first prime point which we have to bear in mind is to increase the energy or working power of the heart, to meet any increased strain which may be thrown on the muscle, so that the heart may react upon and overcome resistances in carrying out its function of blood distribution.

The heart muscle differs from all other muscle in the possession within itself of the conditions essential to regular, and apparently spontaneous action without stimulation; other muscles do not in like manner contract until they are stimulated. The power of rhythmic contractility is then an attribute of cardiac muscle, and this leads up to the consideration as to how far the working of the heart is independent of reflex nervous mechanisms, which, to use Dr. Starling's words, "are directed not so much to

the compensation of vascular disorders by increased effort on the part of the heart, as to the sparing of the heart by the production of some reflex effect which shall counteract the original deviation. Thus a sudden rise in arterial blood pressure as is produced by a general vascular constriction, would in itself tend to increase the work of the ventricles. We find, however, that every such rise of arterial pressure or resistance is accompanied by a slowing of the heart's beat in consequence of stimulation of the vagus centre. This stimulation is partly a direct effect of the high pressure of the blood circulating in the brain and partly a reflex from the walls of the heart itself.

Moreover, it seems probable that any increase of resistance to the emptying of the ventricles excites the terminations of the depressor nerve in the heart, so that impulses ascend to the vaso-motor centre which depress the activity of this centre and cause dilatation in the vessels in the abdomen and other parts of the body.

On the other hand, a fall of blood pressure is followed by a quickening of the heart-beat, brought about partly by inhibition of the vagus centre and partly by a reflex stimulation of the accelerator fibres.

None of these mechanisms, therefore, seem to be directed for the purpose of maintaining that cardiac adaptation which is the necessary condition of compensation in heart disease ; and this conclusion is confirmed by the fact that we may divide all the nerves, afferent or efferent, which supply the heart without diminishing to the slightest extent its power of compensation."

BOTH PULMONARY AND TISSUE RESPIRATION

play an important part in the Nauheim treatment. After the use of the flowing effervescing brine bath for a few minutes (Sprudelstrombad), the writer experienced a sense of suffocation and a distinct smell of chlorine gas, due as he presumed to the evolution of chlorine vapour ; this, however, soon passed off and did not return. It was in all probability due to some temporary inhibitory effect upon the respiratory centre, which for the moment led him to conclude was the direct cause of the excitation of the vaso-motor centre, for his pulse was reduced in frequency and the radial artery became much fuller and considerably increased in calibre with a distinct rise of pressure. That resistant movements must be accompanied by respiratory effort in the treatment of cardiac cases is, I think, usually understood, for we know that the movements of respiration have a direct mechanical effect upon blood pressure, and also influence the heart and blood vessels through nervous channels, and the more or less oxygenated blood brought about by respiration takes effect upon the vaso-motor centre. The pump action of lung expansion is an effective agent in furthering the flow of blood from the systemic veins to the

right auricle and consequently furnishing the blood which is driven on by the left ventricle. Again, the inspiratory descent of the diaphragm brings about compression of the abdominal viscera; thus like massage of the abdomen it is a ready and effectual means of promoting venous flow, thus raising arterial pressure. I have always held that the best effects of massage are due to the power which it undoubtedly exerts in bringing about *respiration of tissue*. The "appetite," as Waller puts it, of tissue for oxygen is so great, that not only will it admit oxygen at low pressure but it will attract oxygen which is held back in chemical combination—it can even take oxygen from compounds far more stable than oxyhæmoglobin. Thus living tissue is capable of deoxygenating blood down to the last trace of oxygen. By this means the blood flow is increased through the muscle. Increased blood flow is thus the consequence and not the cause of increased activity of tissues. The movements of respiration have a direct mechanical effect upon the blood pressure. They also influence the heart and blood vessels through nervous channels, and, thirdly, the more or less oxygenated blood, brought about by respiration, takes effect upon the vaso-motor centre." The influence of respiration on the arterial tone is due to the quality and quantity of the blood circulating in the medulla. If the blood be deficient in oxygen, the vaso-motor centre becomes excited and blood pressure rises, its grey matter, however, becomes exhausted, and following this the arterioles dilate and as a consequence blood pressure falls to and below normal, even, it may be, to the dying out of the vaso-motor centre. *Truly this centre, as Leonard Hill so tersely puts it, is the hub round which turns the wheel of a man's active mental life.*

Dr. Harry Campbell, who has apparently studied the practical effects of respiratory exercises in the treatment of disease, writes thus of its influence upon the heart and circulation.

"The advantages of well-developed lungs are for the most part recognised: the greater the respiratory capacity, the more adequately are the respiratory functions carried on, and the less is the liability to bronchitis, phthisis, and other pulmonary diseases. But another advantage, much overlooked, attaches to good pulmonary development—namely, the facility which large lungs afford to the circulation through them: the greater the vascular capacity of these organs, the less is the work thrown upon the right heart. Now all cardiac diseases, but especially primary disease of the right side, and mitral affections, tend to cast extra work upon the right side; and it is therefore of the utmost importance in all cases of heart disease to secure the maximum development of the lungs. Consider, for instance, what happens in mitral disease. In both obstruction and leakage at the mitral orifice the pressure in the pulmonary circuit is increased—a fact

which proves that the resistance which the right heart has to overcome is augmented. This increased pressure obtains throughout the entire pulmonary segment, both in the pulmonary artery itself, and in the pulmonary veins as they open into the left auricle. The augmented pressure in the latter is obviously compensatory, tending, as it does, to minimise the evil effect of the valvular disease. Now the larger the lungs, so much the less will be the extra force demanded of the right heart in order to bring about the necessary increase of pressure in the pulmonary veins, and the longer will the right heart be able to hold out. Given two individuals suffering from mitral disease, and identical in all respects save that the one has well-developed and the other ill-developed lungs, the prognosis will be very much better in the former case than in the latter.

"The respiratory movements favour the circulation of blood. Thus, with every inspiration blood is sucked into the right heart, while the pulmonary flow is at the same time favoured. They, further, aid the lymphatic circulation, pumping the lymph from the peritoneal cavity into the pleuræ, and from the latter and from the pericardium into their respective lymphatics; and hurrying on the lymph flow in other ways. Such aids to the circulation of lymph are of the utmost importance in many diseases, but above all in heart disease."

The following exceedingly interesting experiment by Dr. Leonard Hill, shows the influence of the *force of gravity* upon the *respiratory* and *vaso-motor* centres, through the compensating agency of the *splanchnic* vaso-motor mechanism in conditions of extreme Heart Failure.

"The spinal cord was divided between the sixth and seventh dorsal vertebræ and destroyed with a stylet as far as the third dorsal vertebra, the axis passed close to the trephine hole.

"The connection in reference to the axis for the carotid pressure made necessary in passing from the horizontal to feet down position is slight enough to be ignored. After the cord was divided in the upper dorsal region the carotid pressure in the feet down position fell to the zero line. Section of both splanchnic nerves produce the same results, likewise the injection of such drugs as curare or amyl-nitrite, which paralyse the vaso-motor mechanism. The heart beats which succeed the primary fall were occasioned by violent respirations. These respirations are of a peculiar gasping type, the abdomen is maintained in the retracted position and deep thoracic inspirations are made, the retraction of the abdomen forces blood up from the veins of the splanchnic area while the thoracic inspirations exert a suction action. The total effect of each respiration was to draw some blood into the right heart and occasion a heart beat. Exhaustion soon followed, caused, no doubt, by the anæmia of the respiratory

centre. This anæmia is shown by the fall in intra-cranial pressure, by the cessation of respiration and of the heart beats and by the apparent death of the animal. If in such an experiment the thorax is opened and the heart observed, the right side is seen to be completely empty when the animal is placed in the feet down position, but it continues to rhythmically contract. The instantaneous recovery brought about by the feet up position is shown, the blood is actually shot out of the vena cava and from the veins of the splanchnic area into the heart."

We are deeply indebted to Dr. Lauder Brunton for many valuable and practical hints concerning the physiology of the circulatory system, which we find in many of his published writings, and which have a direct and important bearing upon the mechano-therapy of heart disease by massage and muscular exercises, as well as upon nutritional processes of the body generally. We know that the three large vascular systems in the body are, first, the skin; second, the intestines; and third, the muscles; and according to Ludwig the vessels of the muscles are as important as both the other two taken together, although I presume he holds that the *immediate* effects upon the heart are greater in the circulation through the splanchnic area than in the circulation through the skin and muscles. In a paper by Dr. Brunton on "Atheroma and some of its consequences" (*Lancet*, 1895), he brings together the precise information which is so pertinent to the comprehension of the beneficial effects of massage and movements upon the heart, that it cannot possibly, as far as I can see, admit of refutation or scepticism, they are probably amongst the best recognised facts in physiology. The following points are abstracted from this paper. "Each time that a muscle contracts it drives the lymph and venous blood onwards; each time that it relaxes it sucks its tissue juice and products of waste into the lymph spaces, and thus the more it acts up to a certain point the more thoroughly are its waste products eliminated. At the same time that the action of the muscle thus pumps away its waste products, provision is made for a fresh supply of nutriment, and as the muscle contracts its arteries dilate and a free flow of blood occurs through them. Sometimes the mechanical obstruction presented to the flow of blood by the contracting muscle may retard the circulation during the actual contraction, but after it is over the circulation through the muscle is greatly increased.

It is well known that without exercise we cannot have the muscles in first rate order, and the same thing is universally acknowledged in regard to the heart. It is obvious, that if the respirations be shallow and few, and if the beats of the heart be feeble and imperfect, the thoracic organs, and more especially the heart and arteries, will suffer in their nutrition. Feeble action of the heart, although in some respects it may be a safeguard

against rupture of weak or brittle arteries, is in itself a distinct evil as lessening the nutrition, both of the organ itself, of the arteries which convey the blood, and of the tissues which they should nourish. *How then is the nutrition of the heart to be improved and its power increased? If the difference between systole and diastole is great, the removal of waste products will be more perfect, and this difference may be increased by causing the circulation to become more rapid, lessening the resistance in the arteries so that they present no obstruction to the heart's emptying itself, and allowing the blood to pour rapidly through the venous system back into the heart, so that it is thoroughly filled during diastole.* By massage the waste products are readily removed from the muscle. The flow of blood through a muscle is enormously accelerated and its contractile power correspondingly increased, even when a muscle has been so much fatigued that it can hardly contract any more; its contractile power is restored by massage. To say that the flow of blood through a muscle is increased threefold by massage means a good deal but it hardly suggests to one the tremendous gush with which the blood flows through a muscle by massage. By the use of massage then the circulation is quickened, the resistance is diminished, the filling of the blood vessels during diastole increased, and thus the pumping of waste products out of the heart itself is more thoroughly effected. At the same time there can be little doubt that a similar increase of blood supply to the heart itself takes place even if the coronary arteries are contracted, and as it is called upon to make no extra exertion, but, on the contrary, to work against less pressure than before, we may expect it to become better nourished and better able for work. But simple massage will not increase the thoracic movements, and *these are important adjuncts.* Therefore it is, that if the patient be strong enough, carefully graduated movements may be added to massage, or replace it entirely. For these movements will increase the flow of blood through the muscles, and have all the other useful actions which have been just mentioned as resulting from massage. This method, known in this country as the Schott treatment, consists chiefly in the use of *graduated* movements which are made at *first* against *very slight* resistance. By this means, as in massage, dilated hearts become rapidly smaller, resistances in the circulation are lessened, and a more powerful action of the heart is engendered."

I now proceed to briefly consider the practical and technical part of this treatment, the clinical features of which have been delineated so thoroughly by Dr. Bezly Thorne and many others. These, however, are not referred to at all here, the chief aim of the writer being to demonstrate the modes of massage, and the forms of exercise which constitute a true mechano-therapy in the treatment of heart cases, and which can be carried out under almost any conditions.

MASSAGE.

The mere fact that kneading and squeezing the tissues increases the flow of blood and lymph through them is not of itself sufficient evidence that we are so influencing the tissues as to obtain the best results in promoting a healthful and durable change in the blood pressures of the heart and the arterioles. On the contrary, my experience of well nigh twenty years has taught me to ignore what I call the Turkish Bath system of *pressure* movements, and to relegate them to past history. In a word, pressure movements are for the most part applied to localized areas to promote absorption; they do not bring about respiration of tissue and cell life, or increase reflex activities in the same degree and to the same extent that *vibratory movements* do. This is an important point in the massage treatment, particularly for heart disease, which I would like to impress upon the Masseur. I have repeatedly proved this by testing the effects produced, not only upon the calibre of the radial artery but also upon the heart by means of the Cardiograph. "Cardiac Failure" from any cause, either "Organic" or Functional, is attended by two main conditions of primary importance, namely, increased backward pressure in the veins and decreased forward pressure in the arteries, and so long as these exist there must be defective functional activity in all the tissues and organs throughout the body, primarily in cell life, notably in the walls of the capillaries, the cells of which, like all other cells in the body, are dependent for their proper nutrition upon a free supply of oxygen and nutrient material, and a free exit for their waste products; this entails diminished resistance and increased permeability. A long continued venous obstruction produces a state of starvation and asphyxia of the cells. Hence it is that in the chronic conditions of Heart Failure we find œdema and dropsy, following increased permeability of the capillary walls, associated with hydræmic plethora, and a fall of pressure, with a disturbance between the normal relationship of the blood and the lymph; in fact, a derangement of balance between the physical conditions which normally control filtration from and absorption by the blood vessels. I have long held that the good effects of massage are determined more by the production of *respiration of tissue* than by the mere mechanical effect of emptying the vessels, or pushing onwards the column of venous blood. I shall, however,

endeavour to demonstrate that the one is subservient to the other, although of differential value. Respiration of tissue is essential to the life activity of all function, and it may be shortly defined as the function or group of functions by which an interchange occurs between the gases formed in the tissues of a living being and the gases of the medium in which it lives. The scientific masseur feels that in his every movement, by every exercise of a well regulated distribution of energy, he is assisting to bring about life processes of the highest standard. That massage relieves an overburdened heart we have proved both by clinical and physiological evidence; it stimulates the vaso-motor and respiratory centres, it tends to liberate oxygen from the hæmoglobin, and it must be attended by the evolution of heat, and an improved metabolism.

In the employment of manipulative processes to the human body in cases of "*Heart Failure*" we have to consider several points in detail: the *first* is, skill, knowledge, training, and practical experience, for without these success is not likely to follow. *Secondly*, the dosage must depend entirely upon the condition of the patient, and under any circumstances it must be carefully graduated. *Thirdly*, under no conditions must the patient be subjected to *strain*, *stress*, or *tension*. *Fourthly*, in commencing a course, which should certainly extend over six weeks, the movements should be of a light vibratory character, and of not more than thirty minutes' duration. *Fifthly*, it is absolutely necessary that the surface of the hand of the operator be brought into contact with the surface of the body of the patient. There are some who believe that equally good effects can be obtained by manipulations performed upon the body when the patient is dressed; this is quite contrary to my own experience. *Sixthly*, no part of the body should be exposed to the air for a longer time than is absolutely necessary; that is to say, every part should be covered and kept warm immediately after the manipulations are discontinued. *Seventhly*, the patient should be in the reclined position. *Eighthly*, absolute rest must be enjoined for one hour after the procedure has terminated. *Ninthly*, half a tumbler of hot milk with one or two teaspoonsful of brandy may in most cases be administered with advantage. *Tenthly*, the patient's extremities must be kept warm by wrapping them in a blanket. *Eleventhly*, the operation should be carried out twice a day, at 11 o'clock in the forenoon and at 5 o'clock in the afternoon. *Lastly*, the diet should be chiefly nitrogenous, and excess of fluid must be carefully avoided.

The question naturally arises, Of the four cardinal forms of massage, namely, Effleurage, Petrissage, Tapotement, and Friction —should all be employed, or either one in particular? In other words, Should the manipulations be executed in the same general way that they would be, say for a Weir-Mitchell case, or in a manner special and peculiar? My answer is decisive, and it is

based entirely upon my own judgment, derived from a thoughtful and observant experience. I need scarcely say that in some organic forms of heart failure, anything like rough treatment would probably lead to troublesome results. There is a kind of manipulation which is, I think, superior to all others in improving the circulation, which is called "Vibratory Petrissage." It is a manipulation associated with considerable rapidity and lightness, and with partial rotation of the wrist. For instance, "A mass of flesh is grasped firmly between the thumb and the fingers of the right hand, and exposed to a series of rapid gyratory shakings with some pressure (the muscle of course being made as lax as possible by the position of the limb), whilst the left hand is employed in pushing forward to the right hand the fleshy substance of the part so that the graspings may be the more completely accomplished." According to my idea the oxygen is more readily dislocated from the oxyhæmoglobin by this means than by any other, and in this manner internal respiration is most thoroughly effected and lessened resistance in the arterioles and the capillaries is more surely brought about than by the ordinary squeezing and kneading methods. Now I am not one of those ignorant twaddlers who talk of the *science* and *art* of massage as being something inextricably bound up with untold movements, but I do hold that if massage is to accomplish what I believe it is best capable of doing, namely, to bring about normal functional activity when it is more or less seriously impaired (and when drugs fail to attain this object), it requires greater practice and attention to details than some physicians are inclined to ascribe it. That I am a bit of an enthusiast concerning the valuable effects of massage, I am not inclined to deny, but I have never written or spoken of its potency in any other way than as an aid to treatment, and a powerful curative agent, for, as Dr. Lauder Brunton says, "It is neither more nor less than the means by which nature itself keeps up the healthy nutrition of every organ in the body, when the utmost pains seem to have been expended upon mechanisms, whereby not only fresh nutriment should be supplied but waste products should be removed with greater or less speed according to the greater or less functional activity of each organ."

INSTRUCTIONS TO THE MASSEUR.

My instructions to the Masseur are as follows:—Place the patient upon a bed which is readily accessible in every direction, and have plenty of pillows close at hand to use as occasion requires, to prevent *postural strain or discomfort*; it is also necessary to have flannel wraps to cover the parts as the manipulations proceed, to prevent undue exposure. The head and shoulders are to be raised, according to the nature and urgency of

the case, passive movements without resistances are employed for the first week, then slight resistances are brought into play, and gradually increased in a measure proportionate to the strength of the heart and circulation. The manipulator's movements are rapid, light, vibratory and percussive, and in reference to the limbs, all the muscles must be in a state of relaxation by flexion so as to fall easily within the grasp of the operator. The whole of the body may be manipulated at one séance or it may be done at twice, namely, the upper extremities, neck, chest, and back in the morning, and the lower extremities and the abdomen in the after part of the day. Of course, due observation must be paid to the respiration, facial expression, and colour of the patient; this is, however, rarely if ever required, and if ordinary care be taken precordial discomfort and laboured respiration will be greatly relieved even during the manipulations, but, as I have before stated, the success of the treatment must always depend upon the care and technical skill of the operator, which cannot be expressed in words. The following will give a general idea of the simplest methods of procedure, which are specially adapted to the treatment of heart cases. Each séance should occupy thirty minutes for the whole body, as follows:—

Right Arm	3	minutes.
Pause	2	,,
Left Arm	3	,,
Pause	2	,,
Neck	1	,,
Pause	2	,,
Chest	3	,,
Pause	2	,,
Back	3	,,
Pause	2	,,
Abdomen	5	,,

For the Upper Extremities.—The operator commences upon either the right or the left arm, by flexing the carpal and metacarpal joints, to be followed by brisk *light* friction movements of the dorsal and palmar surfaces of the hand, which is then grasped *lightly* by the hands of the operator and manipulated *rapidly*. The wrist joint is then flexed and extended, followed by brisk *light* friction of the forearm, which is then squeezed by one upward movement from the wrist to the elbow between the thumb and forefinger, then the forearm is allowed to fall into the operator's left hand whilst with the right hand the muscles are stimulated by rapid vibratory petrissage manipulations. The forearm is then slowly and thoroughly flexed upon the arm six times and brisk friction by rapid rolling movements is applied to the arm, followed by vibratory petrissage of the muscles. The ordinary movements at the shoulder joint follow, and the arm is then

supported by pillows in the most comfortable position to the patient and covered by clothes or eider down quilting to maintain temperature and ensure rest and ease.

For the Lower Extremities.—The operator takes either of the legs first (say the right), and to the foot is applied brisk friction, then the toes are quickly flexed, and the foot is manipulated with light gyratory movements. Flexion and extension of the ankle joint follow. The limb is then flexed at the knee and supported by pillows, brisk friction is applied to the leg from the ankle to the knee, followed by a pressure upward movement in the same direction. The muscles of the calf are then treated by brisk vibratory petrissage; flexion and extension movements at the knee follow. The thigh is first subjected to brisk friction movements, vertical and horizontal, followed by rapid rolling pressure movements, and then the muscles are acted upon by means of vibratory pressure manipulations. Lastly, the movements of the hip joint are brought into play, and the limb is then thoroughly clothed.

For the Neck.—The head is slightly bent forwards, and manipulated quickly and very lightly with the utmost rapidity, by the tips of the fingers. In my opinion the other movements for the neck can be omitted.

For the Back.—The multifarious manipulations as laid down and practised for the back, are only called for in functional heart cases, for the reason that it is inadvisable to have the patient lying upon the face for anything like a prolonged period of time. Therefore (with the patient still in bed), he is made to sit up with the body bent forward, the arms folded and resting upon pillows. In this position, *without strain*, rapid friction movements are applied to every part of the back, particularly in the course of the ribs. Tapotement movements follow with the tips of the fingers, the closure hand, the boat hand, and the ulnar sides of both hands; the latter movement is flipping in character, and produces very effective stimulation.

For the Chest.—I never could comprehend the value of more than one or two forms of manipulation for the anterior surface of the chest, and I never commend more than rapid and light friction, followed by rapid flippings with the ulnar borders of both hands, particularly of the distal ends of the little fingers, and petrissaging the cardiac area by small graspings of the skin with the thumb and forefinger.

For the Abdomen.—Massage of the abdomen to brace up the splanchnics is of considerable importance, and should be carried out with some detail. Now unless care be taken postural strain can scarcely be avoided; it is therefore necessary to have the body as well as the thighs flexed, the shoulders raised and thoroughly supported by pillows, the thighs also raised and *thoroughly* supported by pillows; the bladder should be empty.

It is not necessary to carry out all the customary movements for the abdomen; brisk friction is first employed, then the deeper movements follow, to be succeeded by vibration, and lastly by ulnar tapotement. It is almost invariably my custom to make the patient wear an abdominal belt in cases of heart failure. In addition to these manipulations, passive respiratory exercises are of great utility; they should be carried out after the Sylvester method, viz., the extended arms are grasped firmly by the operator and drawn up vertical with, and over the head. The arms are then flexed upon the forearms and carried well into the sides of the chest. This procedure may be carried out for three or more times, making a pause of thirty or forty seconds between each. It is often advantageous to make the patient use volitional effort, both in flexion and extension when these movements are being performed. Whilst referring to Sylvester's method for artificial respiration, it is well to draw attention to the good effect produced on "weak hearts" by making the subject undergo a form of volitional "respiratory gymnastics," by which there follows an augmentation in the flow of blood from the venous to the arterial side of the circulation. By a succession of six or eight deep inspirations, followed by prolonged and volitional expiration, the abdominal muscles by their contraction compress the abdominal veins, and thus stimulate the heart to increased action.

RESISTANCE MOVEMENTS IN THE TREATMENT OF HEART FAILURE.

THESE movements, which have been so intimately associated with the name of Dr. Schott, and with the commonly called Schott treatment for heart disease, are of considerable interest, and of unquestionable therapeutic importance; in a word, "They consist of *volitional* movements of the extremities and the trunk of the body, exercised against carefully graduated resistances" It might be perhaps said that the movements are *Ling's*, and the graduated resistances are *Schott's*, constituting in combination with the effervescing salt baths, what is now so well known as the "Nauheim" treatment. I have here nothing to say concerning the details of the Nauheim treatment in its entirety, my object being to draw attention to the nature of these resistant movements, and the methods best adapted to their skilful accomplishment.

I would *first* like to notice one or two points relative to movements *without* resistances; *secondly*, to movements with what I call *initial* and *volitional* resistance on the part of the patient; *thirdly*, to volitional movements against *adapted* and graduated resistances.

The healthful influence of the Swedish Method of Physical Education can scarcely be over estimated. It is to Ling of Sweden that we are deeply indebted for its perfect elucidation. In this country at the present time Dr. Roth has clearly shown how, by the aid of its principles, lateral deviations of the spine can be most successfully treated without the aid of mechanical interference, and the excellent system of calisthenic exercises for growing children, which is now generally adopted, is productive of the best results, and will surely lead to a vast diminution of spinal deformities, and to a greater integrity in physical development, as well as to a more complete organization between the nervous, the muscular, and the circulatory systems. The "Neuron" as an anatomical and physiological unit of the nervous system, being dependent upon the due exercise of the muscular system for its nutrient and functional activity, will grow in stability and progressive co-relationship and adaptability by the aid of well timed exercises, so that individual strength and vitality will be proportionately increased, and the body as a whole will secure a greater power of resistance, and will be less influenced by that eternal condition known under the term environment, which is

responsible for the loss of individuality, responsibility, and even moral sense, and which seems to be a marked feature in the human cosmos of this tumultuous age of what is called progress and civilization. That the heart suffers from such causes is universally admitted. Dr. J. E. Pollock, in the Harveian Oration, at the College of Physicians, 1889, draws attention to this in the following words. "I need not say to such an audience as this, that work—the due exercise of every function given to us—kills no man, and shortens no life; the causes are to be found in what is called an extended civilization. We are no longer traders to one country, nor for one or two commodities. The telegraph has introduced us into a wide sphere, and our merchants have interests in every clime, and enter on risks of a kind so varied, that the knowledge of no one man is sufficient to grasp it; hence there are the anxieties of extended speculation, and a necessary want of the perfect understanding of each. The knowledge of one kind of trade was formerly power and led to prosperity; now we are playing games with all the world. Those who are present know what part of the organism it is which generally fails. Under such pressure the public say it is brain, but we know it is heart, the motor power which Harvey studied, although perhaps he did not foresee to what pressure a modern civilization would subject it."

I shall consider *movements* or *exercises* from the simplest possible standard, and with an almost inconsistent brevity. They have such a widespread influence upon the integrity of life activities, and play such an important part in the due performance of function, that their consideration in reference to the heart in particular commands at all times our most serious consideration. Health in its primeval robustness is based upon energy and action, constant molecular interchange, and rarely is volition necessary for its highest forms of development. We are far too prone to speak of volition in reference to skeletal muscle. Rarely is volitional effort associated with the ordinary movements of every day life. Active volitional effort is the concomitant of action necessary to carry out the doing of something which is extraordinary, or beyond the normal range of action. Volition means conscious action. It is an appeal to the higher self in response to thoughtful and purposive cerebration. We are far more automatic than we care to confess. In the movements connected with strained action volition at once becomes manifest, as a necessary corollary, and the ordinary placid flow of energy is converted into a rapid current; high tension succeeds normal tension, with resulting fatigue leading to exhaustion. Volition and fatigue in all striated muscle movements are co-relative. Volitional action leads to fatigue far more readily than automatic action. Volitional action is generally the result of fatigued automatic

activity, leading as we know not unfrequently to inability, defective co-ordination, tremor, cramp, spasm and convulsion. The very perfection of the heart's rhythm is due to the purely automatic character of its muscular activities. When these fail from impaired blood supply or defective nutrition, its neuro-mechanism comes to the rescue, and sustains its feeble irregular and disturbed efforts, until the normal nutritional processes have reasserted themselves, and the cardiac muscle has regained its natural potentiality. Heart consciousness is one of the most distressing of abnormal sensibilities. The resiliency of muscle, and especially of cardiac muscle, is one of its most healthy characteristics. The power of adaptation of the heart to variations of blood pressure, either from defective metabolism or strong emotion, or posture or gravity, toxic influence or disease, leads us to admire and even wonder at its perfectibility. What we know as its compensatory powers are truly marvellous. In using the word adaptation in reference to the power of the heart, I refer to its activities or energies, as an organism as well as a machine, by which its sentient nature is elicited, and through which its action becomes responsive by impressions made upon it from the external world, or to other organisms or organs with which it is more or less directly associated in the human body. I merely refer to this to recall to mind the many and diverse channels by which resistances may be and are created to disturb the normal working power of the heart, not only within but outside itself.

Muscular Movements without Resistances are of two kinds, *active and passive.* Active movements may be volitional or they may be automatic. I am now referring to the simple exercises, such as flexing or raising the arms or legs, or bending the body, which are made at the expense of the patient's own energy; whilst, on the other hand, passive movements are those which are made quite independent altogether of the patient. These are the movements which are described in association with our ordinary massage manipulations.

Muscular Movements with accompanying Initial Muscular Resistance.—These movements are *volitional*, and are best exemplified by flexing the fingers firmly into the palm of the hand and extending the arm completely, bringing the muscles slowly into a state of tension with the arm at a right angle to the trunk, and then, under these conditions, gradually raising the arm (one or both) above the head, lowering it quietly and slowing to the right angle position, and finally dropping it to the side of the body; or the arm may be extended, the fingers flexed firmly into the palm of the hand, and the forearm flexed firmly upon the arm; the fingers and the forearm are then fully extended, and the arm allowed to fall to the side of the body. Each movement must be performed and followed by an interval or pause. At first sight

these movements may not appear of much value, but physiologically they are of real and essential importance. They are accompanied by tension, strain, and effort, but of the mildest kind, the flow through the veins and lymphatics is increased, arterial tension is raised, and the heart muscle is stimulated.

Muscular Movements with graduated resistances, after the method of Dr. Schott.—The patient may be either in the reclining, sitting, or standing position. The operator should be best able to judge which position should be adopted, according to the nature and complexity of the case. It is better in the first stage of treatment to have the patient in the reclining position. In the second stage of treatment, the movements are effected whilst the patient is sitting. In the third stage of treatment, the patient may be sitting and standing, according to the body movements to be exercised, or the extremities which are to be operated upon. Anything more simple than these resistant movements cannot be conceived; the trained mind will readily understand and appreciate their bearings, but the novice will require training in order to become familiar with the movements themselves, and the best modes of applying and graduating the resistance. Those who are acquainted with Ling's, or the Swedish movements, and the passive exercises in connection with massage manipulations, will experience little difficulty in understanding these statements. Before attempting to describe the practical or technical exemplification of these movements, I will give the rules which are laid down in the writings of Dr. Schott, as given by Dr. W. Bezly Thorne.

"1.—Each movement is to be performed slowly and evenly, that is, at a uniform rate.

2.—No movement is to be performed twice in succession in the same limb or group of muscles.

3.—Each single or combined movement is to be followed by an interval of rest.

4.—The movements are not allowed to accelerate the patient's breathing, and the operator must watch the face for the slightest indications of (*a*,) dilatation of the alæ nasi; (*b*,) drawing of the corners of the mouth; (*c*,) duskiness or pallor of the cheeks and lips; (*d*,) yawning; (*e*,) sweating; (*f*,) palpitation.

5.—The appearance of any of the above signs should be the signal for immediately interrupting the movement in the process of execution, and for either supporting the limb which is being moved, or allowing it to subside into a state of rest.

6.—The patient must be directed to breathe regularly and uninterruptedly, and should he find any difficulty in doing so, or for any reason show a tendency to hold his breath, he must be instructed to continue counting in a whisper during the progress of each movement.

7.—No limb or portion of the body of the patient is to be so constructed as to check the flow of blood."

It has been stated that the movements practised at Nauheim are volitional movements, not only of the extremities, but also of the trunk of the body against graduated resistances. The Zander system for muscular exercise by means of elaborate machinery has been in operation for many years, and is now usually adopted in many of the leading spas upon the Continent. Dr. Groedel of Nauheim, thinks highly of these modes of resistant exercises, and says that he decidedly prefers the mechanical to the manual forms of gymnastics. He writes, "We are surer of the right amount of exercise being given, and that it is regular, also of the proper breathing or pulmonary gymnastics, that jerking movements are avoided, etc., etc. Still, there are always some cases for which manual gymnastics are to be preferred." When Zander's system was first introduced into this country some years ago, it claimed a large share of professional attention, but it never met with general acceptance, and gradually died out, although it must be admitted that the machines were most ingeniously constructed and in some cases were of considerable utility. I have thoughtfully considered the two methods of procedure (the manual and the machine) in the treatment of heart cases, and in my opinion the manual method possesses advantages which make it superior in every respect to the Zander.

I will now endeavour to place before the reader the practical application of these resistance exercises as far as it is possible to do so in writing, but any lengthy description is both tedious and unnecessary. We must assume the patient and the operator to be of equal height and reach. It is desirable that the patient be put through all the exercises for at least three or four times before any resistances are created. At first the resistances must be very slight, and their effects carefully noted. By the end of the course of treatment the resistances should be so gradually augmented and strengthened that they produce a sensible and definite effect upon the patient, and herein lies the success of the whole business. One great point in carrying out this form of cardio-therapy is that the physician can himself be the operator. Of course the muscular movements are at first of the most simple kind and unilateral, but as the case progresses bilateral groups of muscles are called into activity. To a certain extent the patient and the operator work together. It must be understood that the following descriptions are intended to be illustrative only.

The Head.—These movements are six in number, namely, forwards, backwards, right and left lateral, right and left rotatory. One finger of the operator may be employed to resist these movements. It is, however, customary to use the phalanges of all the fingers or the entire hand as found

necessary. In the act of bending the head forward the operator's *right* hand is placed upon the forehead to resist the downward movement. Then the operator's left hand is placed upon the occiput to resist the return movement. The converse resistances are used when the head is moved backwards, and so in like manner with the other movements of the head.

The Upper Extremity.—Take *abduction*. The operator places the palmar aspect of his *left* fingers upon the dorsal surface of the patient's extended hand; he then tells the patient to abduct and raise the arm *slowly*, *quietly*, and *measuredly*, in fact, *purposively*, for he has to overcome the weight of the operator's resistance. When the arm reaches a right angle to the body there comes a pause in the movement, and the arm is supported in this position for thirty seconds. It is then carried upwards to a position vertical to the trunk of the body, against a similar form of resistance, followed by a pause of thirty seconds. Then the operator places the palmar aspect of his right fingers against the same aspect of his patient's hand, and the *fully extended* arm is gradually lowered against resistance to a right angle with the trunk of the body. Then follows a pause of thirty seconds, then the arm resumes its normal position. *At each pause the patient is instructed to take as full and deep an inspiration as he is capable of doing*; during the progress of movement the patient counts (say twenty), slowly and in a whisper. Then follows a forward movement. The patient's hand being in a state of supination and adduction, the operator places his hand upon the patient's, who slowly raises the *extended* arm to a right angle with the trunk of the body. (A thirty seconds' pause.) The arm is then raised to the vertical (pause). The arm then descends to a right angle (pause). It then resumes the normal position. Or the forearm may be flexed upon the arm and extended against resistances in the same way as first described. Or the arm may be moved at all angles to the trunk of the body, either prone or supine, against resistances flexed or extended, just as the operator may determine. After the completion of these movements, the operator (standing at the back of the patient) places his two hands firmly on the latero-dorsal surface of the ribs, while the patient is requested to make a deep inspiration (with the fore arms slightly flexed and somewhat abducted at the elbows). The inspiratory effort is supported by the operator bringing the trunk as near the vertical as possible and giving support to the raising and expansion of the chest. Expiration is aided by the operator carrying the body slightly forward and passing the hands with some pressure towards the epigastrium. Or the operator, standing at the back of the patient, presses the arms and shoulders during *inspiration* by placing his hands under the forearms close to the elbow, and during expiration carrying

the arms towards the ribs with some pressure. I never employ resistances to the movements of the respiratory muscles; on the contrary every aid should be given by the operator to the patient to enable him to carry out to their fullest extent what I call prolonged and sustained "Respiratory Gymnastics." These are to my mind of more real value than the resistant exercises of the extremities.

The Lower Extremity.—Resistance exercises of the lower extremities, according to my experience, lead to greater strain and fatigue, unless carefully carried out, than when they are applied to the upper extremities. The patient should be lying down, with the legs extended, and requested to extend and flex the foot, whilst the operator offers resistance by placing his hand concurrently and respectively to the dorsal and plantar surfaces near the toes. The patient then raises the leg against the dorsal resistance of the operator, and allows it to rest against the operator's hand, which grasps it just above the malleoli. The patient then flexes the thigh against the operator's hand, which is placed just above the knee. The to-and-fro movements of abduction and adduction and rotation are then made against resistances, the principles of which have been explained.

In the various movements of the limbs I would say that whilst the operator gives resistance with one hand he may support the limb with the other, but the support must be always minus to the resistance.

Trunk Movements.—Body resistant exercises require more than ordinary care. Postural changes are invariably accompanied by an immediate and decided alteration in blood pressure, chiefly due to vaso-motor influence. I have quoted from Dr. Leonard Hill relative to the effects of gravity and posture upon blood pressure (see page 13.) In some vaso-motor people the mere effect of turning in bed will increase the cardiac beats 20 or 30 per minute, and going up an incline, walking fast, or hurrying, stooping to pick up anything from the ground, even carrying a hand-bag will be productive of extreme breathlessness. I merely refer to this in evidence for notification, and it should not be forgotten. It teaches us that where these movements, with or without resistances, are carried out in Heart Failure, they must be graduated with *slowness*, *pausation*, and *precision*. In fact, the exercises to which I am now about to refer are, plainly-speaking, *plus* support, *minus* resistance. They should not be undertaken before the heart has become accustomed to the resistant exercises of the limbs. The exercises are best effected with the patient standing. The operator uses both hands. The movements of the trunk are *forward*, *backward*, *bilateral*, and *rotatory*. The operator places the right hand upon the chest at the lower part of the sternum, and the left hand upon the back. The patient then inclines the body forward to an angle of 15° or 20°, the operator

aiding the patient to carry out the movement. The patient slowly resumes the upright position. Conversely the body is bent backwards, the operator using the hands as in the preceding movements. The lateral movements are carried out under precisely similar conditions. In carrying out the pseudo-rotatory movements of the trunk the operator, standing at the back of the patient, places the hands upon each side of the chest in the axillary regions, and whilst the movement is being effected, the patient is directed to make a full inspiration. The movement may be first to left, then to right, or *vice versa*. It would be injudicious to execute these movements in any other than a fully-recognised and a limited degree.

If the movements which have been so imperfectly detailed are carried out with due care, they may be rendered applicable to any form of chronic heart disease The danger lies not in the movements themselves, but in their faulty administration.

Sir Grainger Stewart, in his paper previously referred to, writes as follows :—

" My experience of this method of treatment has satisfied me :

1. That in a large proportion of cases it effects immediate improvement in the condition of the heart, as shown by percussion and auscultation, the sounds becoming more distinct and the area of dulness diminishing to a greater or less extent.

2. That in many cases the rhythm of the pulse improves and the beat becomes more vigorous.

3. That while the immediate effect is in so far temporary, the heart rarely goes back to its previous condition of dilatation, but remains somewhat smaller than it had been before the exercises, and that gradually improvement of a lasting kind sets in, so that the heart recovers its tone and the area of dulness diminishes.

In illustration of the effects of the movements I shall refer first to an observation made at Nauheim on August 19th, 1895. The patient was a Russian official, who had been placed under Dr. Schott's care by Professor v. Leyden, of Berlin, and whom, along with Dr. Holman, of London. Dr. Macgregor Robertson, of Glasgow, and several other gentlemen, I very carefully examined. He was suffering from cardiac failure without murmur, anasarca, some ascites, slight hydrothorax, and probably hydropericardium. The left border of his heart before the exercises was nearly 7 inches from mid-sternum, while the right margin was more than $1\frac{3}{4}$ inch. I confess that the condition of the patient seemed to me scarcely one in which treatment by exercises could be entered upon. But Dr. Schott had no hesitation in applying them. They were carefully carried out by Dr. Schott himself and by Dr. Bezly Thorne in our presence.

The patient was somewhat nervous at first, and at one moment I thought was going to faint; but he speedily rallied, and the

treatment was continued. The exercises lasted for twenty minutes. When they had been completed we again examined carefully, and found that the apex beat had moved inwards fully three-quarters of an inch, and that the line of dulness at the left side had changed to the same extent. At the right side the line of dulness had gone in three-eighths of an inch, while the upper margin had receded seven-eighths. The record which I show you is that made from the markings on the body at the time of our examination, and was prepared by Dr. Heineman, of New York, and Dr. Richard Greene, of Northampton. The patient made, as I am informed, an excellent recovery, and was able to climb to a considerable height a month after the treatment was commenced. On September 25th the apex beat had, I am informed, come into the nipple line. Dr. Schott writes me that M. L. has this year again returned to Nauheim in greatly improved health. Except for a little cough in winter at St. Petersburg, he has been very well. He is now quite free from dropsy, and the condition of his heart is greatly better, although he has used no cardiac tonic or other medicine."

Bearing upon the effects of resistance exercises upon the circulation, we find a communication by Dr. Brunton and Dr. Tunnicliffe in the *British Medical Journal* (Oct. 16, 1897). Their conclusions fall under two heads: (1) Physiological, (2) Medical, and are as follows :—

(1) **Physiological.**—(*a*) Locally, gentle exercise is followed by a dilatation of the muscular arterioles with an increased flow of blood through them. This is shown by the fact that after the contraction is over the pulsations in the muscle have a greater amplitude, that is, there is a greater distance between the crest and hollow of each pulse wave than before the contraction. As these alterations in the circulation are purely local, the heart remaining the same, they can only be due to a local dilatation of the arterioles in the muscle, allowing them to empty themselves more rapidly during the cardiac diastole.

(*b*) Generally, the effect of exercise, so gentle as to cause no hurry in the respiration and no increased frequency in the pulse on the general blood pressure, is that during the exercise itself the pressure first rises above the normal, but begins to fall, even during the continuance of the exercise continues to fall, so that at the end of the exercise it has usually reached the normal. After cessation of the exercise the pressure continues to fall. The pressure after the exercise may remain sub-normal for half an hour or longer ; after the expiration of this time it gradually rises again to its initial height.

These results may at first sight appear to differ from those of Oertel, who found that a rise in general blood pressure invariably followed muscular exercise. We believe that the difference

between his results and ours depends upon the amount of exercise taken being different in the two cases. In his experiments the amount of exercise was sufficiently great to cause considerable strain. In one case, for example, the exercise consisted in making an ascent in forty minutes for which an hour was usually reckoned. Although he notes that no difficulty in breathing occurred, yet the respiration must certainly have been quickened.

If we compare the results of our experiments just mentioned with those which we found to follow massage, we notice that the primary rise of blood pressure upon exertion is greater than that caused by massage, but that the subsequent fall is both greater and of longer duration.

(2) **General Medical Conclusions.**—(*a*) In cases where the heart is very feeble, so that the primary rise of blood pressure caused by even gentle exercise may interfere with its action, massage is the mode of treatment best adapted for restoring the circulation. (*b*) That when the heart is sufficiently strong to bear the increased resistance presented to it by the primary rise of pressure occurring during exercise, gentle exercise is preferable to massage, inasmuch as the subsequent diminution of resistance is greater in amount and of longer duration. (*c*) The difference between our results and those of Oertel affords a scientific basis for the practical rule which has been found so advantageous at Nauheim, namely, that the exercises shall not be carried to such an extent as to cause any acceleration of breathing on the part of the patient.

Of the mechanical treatment (hill climbing) adopted by Prof. Oertel little need be said. There can be no doubt that it is exceedingly useful in its own way. At the time it was introduced the Nauheim treatment was not universally known. That the latter form of treatment is more generally advantageous and applicable in cases of heart failure from valvular and muscular incompetency cannot be denied. With the former there is danger, with the latter there is no danger whatever. In a word, the treatment by massage and resistance exercises has superseded that of Dr. Oertel. The "climbing treatment" possesses so many serious disadvantages, the chief of which is "unconscious fatigue" to the heart muscle, that it can only be safely recommended, as pointed out by Dr. Groedel, in cases of diminished cardiac power, resulting from general obesity or of insufficiency and flabbiness of the cardiac muscles in patients with anæmia, associated with a more or less profound state of neurasthenia. I consider the profession is greatly indebted to Dr. Bezly Thorne for the prominent part which he has taken in introducing the Nauheim system into this country. He has met with opposition now and again, of a very feeble kind, but he has maintained his ground, both from the scientific and practical standpoints, and remains master of the position.

The medical periodicals of the last few years have published a large amount of clinical evidence, showing by cardiac area diagrams and pulse-tracings the immediate effects of the Nauheim treatment in toning the heart and circulation. I purposely (as before stated) leave this part of the subject from my paper, the object of which is to draw attention to its technical and not to its clinical aspects.

I must refer to one point to which reference is so constantly made; namely, that in the opinion of some physicians the Nauheim treatment is only adapted to "weak hearts" due to functional causes. To this statement my opinion is in direct opposition. The Nauheim treatment is applicable to all forms of heart disease, whether they be "organic" or "functional," but for physiological reasons which I have attempted to show, it is most useful in effecting compensation in those cases where failure is due to malnutrition from structural causes. In either condition judgment must be exercised as to the nature and strength of the resistances to be employed, and practical skill in these matters can alone be productive of good results. It is the same in all forms of treatment, to which there is absolutely no exception.

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