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PART I.  
**FUNCTIONAL DISORDERS OF THE HEART.**

**E.M. Hale, M.D.**

LECTURE ON  
**DISEASES-OF THE HEART.**

**INTRODUCTORY LECTURE.**

**The Wonders of the Heart — Its Functions — Increased Frequency of its Diseases — Its Anatomical Peculiarities—Its Circulation — Its Innervation —Its Nervous System — When it Begins to Beat — Pathological Deductions.**

GENTLEMEN: I approach the subject upon which I have been appointed to lecture with the fullest and deepest sense of its importance. Diseases of the heart, from their very nature, and the paramount importance of the organ affected, should claim the interest and profound attention of all thinking and conscientious physicians. I do not wish to exaggerate the importance of cardiac diseases, or give a false estimate of their frequency, but I have no hesitation in asserting, that my observations in a large practice of twenty years have convinced me that diseases of the heart, and especially functional disorders of that organ, have largely increased within the last decade. It may be owing to the fact that the latter half of my years of practice have been spent in a great city, that I have come to this conclusion. The intense strain upon the nervous energies incident to the business and pleasures of a city life, do certainly have much to do in the causation of certain heart diseases. In the country, life is calmer, and its tide flows slower, and the vital energies are less subjected to violent aberrations.

In view of these facts, it becomes us to study well this organ—the heart—in all its relations, not only anatomically, physiologically, but psychologically. And in order to do this, we must first inquire into the character of this organ. Is it merely an appendage to the body—an organ of elimination or secretion? Or is it the centre of the blood-system, just as the spinal cord is the grand centre of the nerve-system, and the brain the centre of the mental forces?

As the brain animates the body with intention and purpose, and the lungs give it corresponding motion, the heart, as the blood's executive power, gives corporeal substance to the frame, inasmuch as the body itself arises from the blood. The existence of the human machine

depends upon the heart, but its usage upon the lungs and brains. The heart is the source whence the finished blood descends to the organs throughout the system, and, as the life is in the blood, the heart is the agent for bestowing that life upon the organization. In a word, the heart, or blood, determines the fleshly tenement.

### **ITS ANATOMICAL PECULIARITIES.**

Anatomically the heart is a conical, hollow muscular organ, lying obliquely in the chest, between the two lungs, the base of the cone pointing upward in the direction of the right shoulder, the apex pointing to the space between the fifth and sixth ribs. It rests upon the tendinous portion of the diaphragm, which is the partition between the chest and the abdomen, and it is encased in a peculiar bag or capsule, the pericardium, which consists of two layers; the outer, fibrous, by which the pericardium is attached to the great vessels at the root of the heart; the inner, a serous layer, continuous with the serous membrane which covers the outer surface of the heart. The cavity between the heart and pericardium, thus lined by a serous covering, generally contains more or less fluid, whereby the heart is lubricated on the outside, and its local motions are rendered easy.

The heart comprises four cavities, two auricles, and two ventricles; one auricle and one ventricle being on each side, and the right pair of cavities being devoted to the circulation of the venous blood, the left pair to that of the arterial blood. The auricles are at the top, constituting the base of the heart; the ventricles form the apex; the latter are much stronger than the auricles, consisting of very thick muscular walls, the reason of which we shall see presently.

### **THE CIRCULATION OF THE BLOOD.**

The heart is a peculiar muscle, and when any of its four cavities contract, they have the power of expelling their contents, the force of the expulsion being the prime mover of the circulation of the blood. We may begin the circle where we please and we shall find that it returns into itself. Starting, for instance, from the *left* ventricle, we see that the blood is driven, by the contraction of that cavity, into the aorta—the highway which leads into all the arteries of the body; through these the blood is discharged into the veins, which unite to form at last only two great trunks the venae cavae, which are again the thresholds of the heart, and debouch into the right auricle. The blood which has now passed from the left ventricle to the right auricle, has still a journey to make before it completes its course. Accordingly, from the right auricle it is forced into

the right ventricle, and by the right ventricle into the pulmonary artery, which conveys it to the lungs, where it ramifies through the multiple branches of that artery, and whence it is brought back by the pulmonary veins, forming ultimately four large trunks, which empty into the heart's left auricle, by the contraction of which the blood is next forced into the left ventricle, to the place from which we began.

Without entering into a description of the complete circulation of the blood throughout the body, with which you are all doubtless familiar, we will consider a more important and interesting subject, namely: the circulation of the blood in the heart *itself*.

### THE CIRCULATION IN THE HEART.

That there *must* be a circulation in and through the heart is evident; for how else could the heart be nourished? The heart is supposed to be nourished by the *coronary* vessels; they are called coronary from *corona*, a crown, because they run in crowns or coronal circles around the heart. They arise from the aorta, close beside the semi-lunar valves, and running around the base of the heart, and sending branches clown the lines of partition between the four-fold chambers, they form a kind of vascular cage-work in which it is contained. The coronary veins, said to begin from the minutest twigs of the coronary arteries, by their considerable branches for the most part accompany those of the arteries, and discharge themselves by one, two, or three orifices, into the right auricle. The interior of the four cavities of the heart is not a smooth, even surface, but is rendered extremely irregular by muscular columns, projections, and partitions; it is scooped, channeled, and caverned, besides which, on the walls of the cavities there are minute openings, the foramina of Thebesius, which are supposed to be the mouths of little veins.

It is a curious fact that nearly all the old anatomists, and some also of the moderns, have suspected a puzzle in these coronary vessels. They come from the aorta, and run backward to the heart. In a certain proportion of cases, estimated as 5 in 20, one or more of their orifices lies behind the semi-lunar valves, and such orifices, it is clear, cannot receive the streams propelled from the heart, because it lays down the valve flat upon them, and effectually closes them. As, therefore, nature's law must be constant, it was argued that what holds of one orifice must hold of all, and that the blood runs back into the coronaries from the aorta when the heart's contraction ceases. This was Boerhaave's opinion.

Swedenborg, however, one of the profoundest anatomists and physiologists of any age, propounded another view. He argued that the raising up of the semilunar valves during the contraction of the heart, when the blood is expelled into the aorta, precludes its passage then into

the coronaries, and that the stretching of the coronaries, and their pressure by the full aorta, contributes to the same preclusion. He held that the coronary arteries do not arise from, but terminate in the aorta; that they are veins relatively to the heart, although running into the beginning of the arteries of the body. The doctrine, in brief, is this: that the heart, as the head of the vessels and the fountain of the blood, itself requires the firstling blood for the exercise of its noble offices, and cannot hold\* its life by tenure from one of its own arteries, which would be to invert all ideas of the order of nature.

The heart is already full of blood, and if fluids, or fluid persons, like solid persons, move with greater velocity in proportion to their life, the best blood in this race will continually outrun the rest, and always first in the heart, will skirt along its porous walls. Now, what structure do we find upon these walls, but caverns, jagged cavities, and at the bottom of these a number of little holes, the foramina of Thebesius. Into these caverns, then, miniature ventricles in the great ventricle, hearts of the heart, the quickest blood is received, and the pores open with all their hearts to take it in. And when the heart contracts, it drives out the general blood of the body into the grand aorta, but its own particular blood, detained in the cavernous lacunae, it squeezes, slippery with spirit, through its walls, into its muscular substance, and thence onward and outward to the surface, into the coronary arteries and the coronary veins, from which there is a reflux, when necessary, into the auricles and ventricles.<sup>1\*</sup>

According to this explanation, which we cannot hesitate to accept, the heart has a circulation of its own, which gives it a power to maintain its own constancy in the midst of the fluctuations of the blood, and to make it the head, ratio, or balance, as well as the heart, of the too-mobile circulation.

Again, according to this view, the varying quantities of the blood returned upon the heart, find an outlet through the walls of the heart itself, and equilibrium is thus maintained by the coronary vessels; so that the heart, *plus* the coronaries, equals all the forces of the circulation; while the heart, *minus* the coronaries, is a comparatively regular force uninfluenced by the general state of the system. Were it not for such provision, the heart would be at the mercy of extraneous influences; the most important organ of the trunk would have no stability, would in the end yield, and be distended into a bladder or membrane, incapable of anything but the most passive reciprocity.

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<sup>1</sup> \* Dr. Wilkinson—"The Human Body and its Connection with Man."

Next to the consideration of the circulation of and in the heart, and its nutrition, the next in importance is

### THE INNERVATION OF THE HEART,

Or, the nervous circulation or nervous forces which impel and regulate the motion of this wonderful organ. The heart is endowed, above all other organs, with a property which has been termed *irritability*, by which is meant the capability of being easily excited to movements of contraction alternately with relaxation.

After the heart has been removed from the body, and has ceased to contract, a slight irritation will cause it to execute, not one movement only, but a series of alternate contractions and dilatations, gradually diminishing in vigor until they cease. The contraction begins in the part irritated, and then extends to the rest. And it appears that it is the muscular tissue alone that possesses this peculiar property, for if the parts of the heart experimented upon are connected by tendons the irritation will not extend through such connection. This irritability is less speedily lost in cold-blooded than in warm-blooded animals. The heart of a frog will go on pulsating for many hours after its removal from the body; and the heart of a sturgeon when inflated with air, continues to beat until the auricle absolutely becomes so dry as to rustle during its movements.

Not only will the *whole* heart continue to beat when removed from the body, but even small and isolated portions will contract and relax with great regularity. Cut the heart lengthwise into two halves, and each half will continue beating. Cut it across, through both auricles and ventricles, and both sections will beat as before. The auricles will persist in their rhythmical action when cut off above the auriculo-ventricular rings, and the apex of the heart will do the same when separated from the rest of the ventricles.

This is one of the spectacles which assail the mind of the student with somewhat of a tremulous awe. The beating of the heart, which from his childhood he has learned to associate, in some mysterious manner, with life and emotion, he here sees occurring under circumstances removed from all possible suggestions of emotion or life. All connection with the spinal cord is severed. The brain cannot send to it any voluntary influence. The blood no longer courses through it, to give it motion by contact or otherwise. What then causes the heart and each separated portion to continue their rhythmical pulsations? This irritability does not depend upon the cerebro-spinal system, for it has been proved that the heart's action will continue in the body after the brain and spinal cord have been removed. For many years no explanation could be given of this

wonderful self-life of the heart. We now know that the heart has a *nervous* system of its own, as well as a *circulation* within itself.

In the substance of the heart is a complete little nervous system, consisting of ganglia and nerves, and is not made up of the nerve filaments which come from the *pneumogastric* nerves. From these ganglia nerves are distributed through its muscular substance. It is to this nervous apparatus that we must ascribe the spontaneous action of the heart; for if any part be severed from all connection with the ganglia the pulsations will cease at once, but if the smallest severed portion of a heart contains a ganglion the pulsations will continue. In other words, it retains its irritability. The movements during life or death are due to these ganglia. No other ganglia in other parts of the body retain their power after the circulation has been destroyed. In view of this, we might almost believe the fanciful notion that the heart was a sentient organism—a being within a being!

But the most wonderful thing about the heart remains to be told. *It pulsates in the embryo long before it contains blood, and long before any nerves have been developed in it—when, indeed, it is nothing but a mass of cells !* What is the essential nature of these cells? Does each one possess the property of spontaneous movement? Do we know the nature of the stimuli which cause this movement? And when does this movement begin?

#### WHEN DOES THE HEART BEGIN TO BEAT?

In discussing this question, a certain eloquent writer says: “The essential unity of the rhythmic beat of the heart, and the amoeboid movement of protoplasm, are well shown by the history of the new-born heart. In the chick growing within the egg the heart begins to beat very early, while as yet it is built up of nothing but protoplasmic cells. Many authors, over-jealous, as it seems to me, for the prerogative of nerve-cells, find satisfaction in affirming that these constituent cells of the young heart, though apparently alike in structure, are various, some being potentially nerve-cells, others potentially muscle. To my mind, each and every cell is not only potentially, but actually, both nerve and muscle. So long as they are still cells, that is, still tiny masses of untransformed-protoplasm, each enjoys all the powers of life. What befalls them afterwards is not gain, but limitation and loss. Some cells lose the power to move, and so become nerve-cells; other cells lose (to a great extent, at least) the power to originate impulses, and so become muscular. Very interesting is it to watch how the slow, irregular, drawling movements of the primordial protoplasm are gradually transformed and gathered up into the sharp, short stroke of the heart's beat. We speak, in common language, of the heart of the chick as

beginning to beat on the second or third day of incubation. It is then that its beat becomes obvious to our senses as a beat. But, in reality, it never does begin to beat. There is no sharp line of demarcation between the protoplasmic crawl and the true rhythmic spasm; the one, little by little, merges into the other. To borrow an illustration from music, it might naturally be imagined that, the matter took place in this wise: 'We might fancy that the tiny cells were marshaled in their places round the cavity of the heart, as musicians are marshaled in an orchestra, fully equipped with powers of rhythmic pulsation, but quiet and inactive; and then, that at a wave of the wand of the great conductor, at the moment when fuller life was breathed into every cell, all struck up in unison with the heart-beat. We might fancy, I say, that this was how the first stroke was wrought. But it is not so. To gain a truer image of the process, we must think of ourselves as listening with eagerness, a long way off, to a multitude of performers assembling together, each playing on the same instrument, but playing in a different way, though all trying to learn the same tune, and all » gradually drawing near to us. As we listen to them with stretched ear, coming nearer and nearer, and as, at each moment, more and more performers fall into the one proper time, the initial discordant noise, as it gathers in intensity, also gradually puts on a definite form, and at last there comes a moment when we say, ' Now I hear them ! Now I have the tune!' So it is with the growing heart. Looking at it earnestly with the microscope, we may fancy ourselves witnesses of how the cells, as they assemble together, little by little exchange the all-sided flow of protoplasm for the limited throb of a muscular contraction, gaining in force what they lose in form. And so there will come a time when we can say, ' Now I can see it beat;' though in reality it has been beating a long time before."<sup>2</sup>

### PATHOLOGICAL DEDUCTIONS.

From a pathological point of view, this peculiar nervous structure of the heart is important. It teaches us that certain diseases of the heart may originate within itself—*i. e.*, are *idiopathic*. Especially may this be the case with the disorders known as functional or nervous. Thus, in some cases the functions of the body may be perfectly healthy, while the heart is disordered. *Its* nervous system may be deranged, while that of the body may be in perfect health.

'We are also taught, by the fact of the heart's peculiar irritability, that we cannot always decide on the existence of life or death from the presence

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<sup>2</sup> Dr. S. Foster—"Wonders of the Heart."

or subsidence of its movements. The heart may be still beating in the body while the body has been dead for hours; and the heart may cease to beat while the body lives. The hearts of decapitated criminals have been observed to beat two, four, and even seven and twenty hours after the operation! On the other hand, many instances have been known where the heart's action could not be discovered for hours, yet the patients recovered. In those morbid conditions known as trance and catalepsy, the heart's action may appear to be suspended for hours, days, and even weeks—the patient meanwhile retaining consciousness. In this condition of apparent death many persons have been buried, and some remarkable cases of burial and resuscitation are on record. In syncope or fainting the consciousness is lost, no action in the heart can be perceived, even by auscultation, for many minutes, yet by the proper use of stimuli the patients recover. M. Bouchat says if the heart's action ceases beyond five minutes death is certain, and he declares that the circulation can be *heard*, when it can be detected by no other means, but this assertion is open to much doubt.

But aside from this self-life which the heart possesses, it has a life imparted to it from the brain and spinal cord. The heart receives nerves from the cerebro-spinal system, and also from the sympathetic. From the former it is supplied by the cardiac branches of the pneumogastric and the lately-discovered motor and sensory nerves, which go to the heart directly from the spinal cord; but the pneumogastrics may be severed at their origin, and the heart continue to act; and, what is more astonishing, the cerebrospinal centres may be removed from an animal without arresting the heart's action. In those monstrosities some times called into being, no brain or spinal cord exists, but they nevertheless possess a regularly pulsating heart. The heart may be isolated from all connection with the sympathetic system, and yet continue to pulsate.

These are important facts for you to remember, in connection with the use of the medicines for the relief of cardiac diseases. A remedy may act upon the cerebro-spinal or the sympathetic systems; but if these systems refuse to respond to the medicinal stimuli, the heart will not feel the action of the curative agent. On the other hand, a remedy may act on the heart, even if the nerves leading from the great centres of the two systems are severed or paralyzed, for it may act by being carried in the blood directly to the heart, there to act upon the ganglia which lie in its structure. THE PHYSICAL POWER OF THE HEART.

Another wonderful thing about the heart is its immense physical power. It is built up of muscular fibres in such a way as to give it a strength possessed by few other muscular structures. Every time it pumps blood into the arteries it exerts a force which is estimated at *thirteen pounds*. The usual force constantly exerted by the healthy

human heart, it is estimated, would sustain a column of blood feet high, the weight of which would be about 41bs. 6oz. Imagine, if you will, an organ exerting this immense force — hour after hour — day after day— year after year — and you can form some idea of the aggregate power of the heart during the life of a man. Not only is the power of the heart wonderful, but its sensitiveness ' is peculiar and unparalleled. As the blood courses through its substance, even into its innermost recesses, it feels the presence, in some way or other, of everything which has found its way into the blood. All poisons, the elements of maladies, the essential portions of all nutritive material, and even the emotions of the mind, influence the heart's motion, and the beat is altered by such influences. Disease may accelerate its pulsations to 140 or 150 per minute, or cause them to sink as low as 25 or 30. So is it with certain medicinal agents. By their use we can alter the heart's force, the frequency of its beats, its regularity of rhythm, and other qualities.

The heart is influenced by all the forces in nature; by all mental and physical influences. "Hence, also, it is that it never wearies. Let me remind you of the work done by our hearts in a day. A man's total outward work, his whole effect upon the world in twenty-four hours, has been reckoned at about three hundred and fifty foot-tons. That may be taken as a good ' hard day's work.' During the same time, the heart has been working at the rate of one hundred and twenty foot-tons. That is to say, if all the pulses of a day and night could be concentrated and welded into one great throb, that throb would be enough to throw a ton of iron one hundred and twenty feet into the air. And yet the heart is never weary. Many of us are tired after but feeble labors; few of us can hold a poker out at arm's length without, after a few minutes, dropping it. But a healthy heart, and many an unsound heart too—though sometimes you can tell in the evening, by its stroke, that it has been vexed during the day, that it has been thrown off its balance by the turmoils and worries of life—goes on beating through the night while we are asleep, and, when we awake in the morning, we find it at work, fresh as if it had only just begun to beat. It does this because upon each stroke of work there follows a period, a brief but a real period, of rest, because the next stroke which comes is but the natural sequence of that rest, and made to match it; because, in fact, each beat is, in force, in scope, in character, in everything, the simple expression of the heart's own energy and state."<sup>3\*</sup> We will now consider the heart psychologically, or the

### **RELATIONS BETWEEN THE MIND AND THE HEART.**

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<sup>3</sup> "Wonders of the Heart," by Stephen Foster,

The heart is one of the so-called involuntary muscles, an organ which is supposed to be beyond the influence of the *will*, if not of the mental sphere. But this view of the nature of the heart's relation to the mind is not entirely correct, for, as Dr. Holland has remarked, "the action of the heart is often quickened, or otherwise disturbed, by the mere centering the consciousness upon it, without any emotion or anxiety. On occasions where the beats are audible, observation will give proofs of this, or the physician can very often infer it while feeling the pulse, and when there is liability to irregular pulsation, such action is seemingly brought on, or increased, by the effort of attention, even though no obvious emotion is present."

Dr. Murray, writing of "Emotional Disorders," says, "The heart is an organ highly susceptible of emotional excitement, and even the strongest *volition* and coolest temperament will not give immunity from this susceptibility. Thus easily excited, in those of nervous temperament the organ is ever been disturbed by emotion. Note, for instance, the palpitation or paralysis of fear, and the intermittent action of a weak or unhealthy organ when it is under the influence of emotional excitement. Further, we have more than once noticed, that long-continued anxiety will lead to a weak and slow action of the heart, causing the pulse at the wrist to fall below its normal standard, both in frequency and force, and at the same time rendering the organ liable to become excited and turbulent on the slightest accession of new emotional feelings."

Indeed, such is the influence of emotions on the heart, that a sudden and painful shock to the feelings has been known to arrest its action, or to excite it to an action so turbulent as to injure its valves or their tendinous cords. The phrase "died of a broken heart" is not purely figurative, for the heart has been *ruptured* by violent emotions, resulting in sudden death.

*Terror* may paralyze the heart, and so may joy when it suddenly seizes upon a person already overpowered by despair. The Roman matrons, after the battle of Cannae, on seeing their sons, whom they supposed to have been killed, dropped down dead on the spot. *Fear*, the chronic form of fright, occasions a tremulous palpitation, not the full, bounding beat of energy or courage. *Rage* produces precordial oppression, and has been known to bring on an attack of angina pectoris. I have known excessive grief, from disappointed affection, to cause not only functional disorder, with irregular and feeble pulse, but those abnormal sounds in the heart which indicate deranged action of its valves, while, at the same time, the patient grew pale and anemic. As a rule, hope will excite and sustain the organ; despair and anxiety will depress it; and contentment and peace of mind will give it healthy action.

It is my conviction that but few physicians have realized the importance of the subtle relations of the brain or mind with the heart; or appreciate the connection between the soul and that centre of physical life. We might go so far as to assert, that as there is a corporeal heart, which is the life-giving centre of the body, so there must be a spiritual heart, which is the centre of soul-life. Else, why do we continually use the word "heart," as applied to the feelings, impulses, and emotions? We say, a man "has a heart," or "no heart," that such an emotion "comes from the heart," or "comes from the head," indicating thereby that one kind of feeling or impulse may be from the soul, and another from a more "calculating" origin. All the grand, noble, loving, and impassioned impulses of our nature are said to come from the "heart; "while the cold, unemotional, and more practical acts are said to emanate from the brain. As a rule, what is deeply rooted in the natural convictions and expressions of the people, has its origin in truth, and so is this accepted correspondence between the feelings and the passions of the soul, and the physical heart, based upon a correspondence between the heart, which is the central life of the body, and love, which is the central life of the soul.

But the *will*, as well as the emotions, may affect the heart. Many cases illustrative of this assertion are on record. The best authenticated case is that of a Col. Townsend, of Baltimore, which was described by Dr. George Cheyne, who was a witness of the fact. The case was that of a gentleman in apparent health, who by an effort of the *will* could at any time cause an *apparent* cessation of all the vital functions, so that the *heart's action could not be perceived*, nor any respiratory movements be observed.<sup>4</sup>

It is a fact well known to anatomists, that animals possess the power to move and govern certain muscular organs and muscles, while man, possessing the same muscular structures, has no apparent influence on them. How far this influence extends to the heart is a problem which may well attract our attention. We should not overlook this sympathy between the mind and the heart. A full appreciation of it may lead us to form opinions and diagnoses, which could not otherwise be correctly made. A physician may be treating the heart with medicines, when his efforts *should* be directed to a "mind diseased." We should never lose sight of the psychological relations of the heart, as well as its anatomical, physiological, and pathological history.

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<sup>4</sup> Treatise on Nervous Diseases, p. 307.