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ON DIGITALIS: ITS MODE OF ACTION
AND ITS USE.*

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Manner of Action.—We have seen in a previous section how the administration of digitalis in physiological experiments is followed by increased contraction. It is obvious that this can only take place in one of two ways, viz., by stimulation of the cardiac ganglia, or by paralysis of the fibres of the vagus. These are, then, the two theories which exist. We will consider, first, the theory of Traube—that of paralysis of the pneumogastric fibres.

1. *Theory of Traube.*—This theory took its rise in the tumultuous movements which result from the section of the vagi. When both vagi were cut, tumultuous and irregular vermicular action was observed to result. That is, the nerve-force was still passing into the sympathetic, which were in full activity, while no longer was there any co-ordinating power in action. It must be admitted on the side of Traube, that certainly digitalis did not act so rapidly on animals where the vagi were cut (see the experiments of Handfield Jones); but, on the other hand, it is more difficult, on his theory, to see how it could act at all after that. Also, section of the vagi only produces death slowly, and that by hepatisation and disorganisation of the lungs; and the most complete paralysis could not be more effective than section. Now, the administration of digitalis in full doses brings the heart to a standstill as a primary action, and that, too, at an early period. There is no apparent connexion between the administration of digitalis and section of the vagi, except an increase in arterial tension, as tested by the hæmadynamometer—the test used by Traube. Winogradoff, from a similar series of experiments to those of Traube, came to opposite conclusions. Niemeyer states that he has clinically been compelled to emancipate himself from the bonds of Traube's theory.

2. *Theory of Stimulus to Cardiac Ganglia.*—This theory was announced by Dybkowsky and Pellikan abroad, and supported by Handfield Jones, with Fuller and others, in this country. This theory is, that digitalis acts as a stimulus to the cardiac ganglia, and thus produces the increased muscular contraction. It is almost needless to remark here, that in no way could the stimulus to the nerve-ganglia manifest its results except in muscular energy—i.e., increased action of the muscular fibres under their control. The increased action and irregularity can as easily be conceived to result from a disturbance of balance through over-action of the cardiac ganglia, as in paralysis of the opposing fibres of the vagus. That this irregularity does result, is unquestioned by either side. In order to settle the question of these opposing theories, Eulenberg and Ehrenhaus took out the heart of a frog, and dipped the lower end, or apex, into a solution of digitalin; the rhythmical action which goes on under the action of the cardiac ganglia, when the heart of a cold-blooded animal is cut out of the body, and when no longer any nerve-force is coming in from vagus or sympathetic fibres, and which contrasts with the tumultuous action which follows section of the vagi when the other nerves are intact, was interfered with; if the solution were weak, the action was rendered slow and irregular; if strong, the motion was stopped. Some light, too, is thrown on this intricate subject by observing the effects of digitalis on other organs where no inhibitory action of the pneumogastric exists. Dickinson found the action of digitalis beneficial in menorrhagia, from its contractile effect on the arterioles. Malan watched the contraction of the capillaries (to dispute whether they are capillaries or arterioles would be out of place here) of a frog's foot under the microscope—an experiment corroborated by the writer. On the application of an aqueous infusion of digitalis leaves, a contraction of the vessels of the web was found to follow, and to proceed to such an extent as to interfere materially with the circulation, bringing it nearly to a standstill: of this some further account will be given in the section on the action of digitalis on capillaries. The inhibitory action of the pneumogastric could have no place in these last named observations. And from the obvious difficulty attending Traube's theory, and the direct evidence in favour of the other, I am led to unhesitatingly side with the latter. The action of the

stimulated cardiac ganglia is too much for the action of the vagus; and thus, instead of an almost synchronous contraction, as is normal, the action is seen to be distinctly vermicular. A long peristaltic contraction is followed by an imperfect diastole and distension, until a state of permanent systole is attained, exactly corresponding to the process of the application of electricity to the sympathetic, and in no way analogous to the results of section of the vagi—than which no paralysis could be more complete as regards abolition of function. The results, too, of the administration of digitalis after aconite poisoning had been established, would necessitate the theory of aconite acting as a stimulus to the fibres of the pneumogastric, if Traube's theory of the action of digitalis were true—a conclusion which is not warranted by what we know of aconite.

Action on Capillaries.—The action of digitalis on the capillaries, as observed by M. Malan and the writer, is in unison with the above mentioned theory of its action on the cardiac ganglia. From the same portion of the splanchnic system arise the vaso-motor system of nerves, regulating the size of the lesser arteries and arterioles, but not capillaries. Be this as it may, and granting that capillaries do not possess the power of contraction, and that, therefore, the vessels must have been arterioles if they contracted, unquestionably the application of infusion of digitalis to a frog's foot produced contraction of the vessels of the web. While the corpuscles had before been coursing down them in single file, they were now arrested and passed with great difficulty, in many parts of the field being arrested altogether. The flow through the capillaries was no longer a continuous flow, in which the impulse of each ventricular contraction was lost; the circulation was by pulses corresponding to each beat of the heart, during which each corpuscle moved about twice its own diameter forwards. On the application of digitalis systemically, consequent increased ventricular contraction became conspicuous, each corpuscle now travelling about four times its own diameter; but the general condition was not altered. Further observations as to its effect on the capillaries may lead to further knowledge; and the writer regrets that circumstances have interfered with his prosecution of this branch of the inquiry. Enough, however, has been observed to demonstrate that digitalis has a direct action on the minute vessels; and in practice that fact must not be forgotten when digitalis is administered for the sake of its effect on the muscular walls of the heart, and the condition of the vessels between the heart and small vessels—viz., the arteries—is registered.

General Observations as to its Effects when Administered Clinically.—It may be well to give a summary of the effects of digitalis when clinically watched, before proceeding to instances of particular disease. The early administration of digitalis was conducted on the theory of its being a cardiac sedative. The reason for this theory was, that palpitation and irregularity were relieved by its administration; and hand in hand with this went on the theory of these derangements, especially palpitation, being over-actions of the heart. That in reality they are evidences of deficiency rather than excess of power on the part of the heart, we now all know. With the exception of excitement, which is visible in its effects on the pulse, we now know that there is no such thing as over-action of the heart. Hypertrophy is, without exception, a compensating growth to overcome some obstacle; though Niemeyer would except one class of cases where he considers it a mere result of plethora. We can no more imagine a heart undergoing spontaneous uncalled for hypertrophy, than we can fancy a similar action going on in the bladder or bowel. It is too obvious that the increase in muscular tissue is called forth only by a necessity for it. Palpitation may occur with hypertrophy; but it merely gives evidence that that hypertrophy is sufficient. Palpitation is an evidence of over-taxation, whether it occurs in hypertrophy or in dilatation. Nevertheless, the administration of digitalis is followed by a quieter action, but that is by its restoration of the conditions to the norm, or an approach to it. Under digitalis, the pulse becomes steadier, firmer, and less compressible; the excited stroke of palpitation is steadied into the normal, quiet, effective contraction; the system is relieved; dyspnoea, the external witness of pulmonary congestion, is abated; the deficient secretion of urine, which tells us that the pressure on the glomeruli of the Malpighian bodies is lessened, is improved, and free secretion takes its place: dropsy is thus often relieved. The general condition of cyanosis is abated; there is evidence of a better circulation throughout the system generally. Frequently, the gradually widening circle of troubles which are involving the patient's existence, gradually diminishes after an improvement is inaugurated in the circulation. The spell which bound the system in a load of ever-increasing fetters is broken by the administration of a drug whose action is unquestionably to produce better, more complete, ventricular contraction; and in that, and that only, I believe the magic lies. When we consider the extreme tendency there is for a condition of cardiac engorgement, or distension to

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result from any prolonged debilitating cause, or acute disorder, and that, too, especially in the right or truly venous side of the heart; when we consider how that again tells on every excretory organ, from the lungs in front to the kidneys behind, and how that leads directly to non-excretion, and how blood-poisoning is engrafted on partial blood-stasis; how the left side of the heart is encumbered between the two burdens of poisoned blood and venous congestion—we can readily appreciate a drug which will enable these chambers to more completely empty themselves, and thus to direct better blood-propulsion, and can understand its extreme therapeutical importance. It is of the utmost importance that we really understand in the administration of digitalis what we can fairly expect of it, what it may be fairly presumed to be able to do, and what experience tells us it has done before. It is obvious that when all is well, neither we nor any patient would wish to administer it or any other drug; we now know that there is no deviation from health except in a downward direction. It is obvious that the most perfect action of the heart is when we are unconscious of its labours. It is equally obvious that those symptoms which tell us that it is at work, are really evidences that the heart is labouring, in both senses of the word. It is for a condition of inability on its part that the physician is consulted by the patient; and though it is possible that now and then its efforts can be strangled by a sedative, or allayed by a narcotic, it is equally obvious that neither can be styled a scientific treatment; for permanent relief we must look for something which will really aid its efforts; and to this, and for the condition under which digitalis ought to be administered according to the experience of the writer, the next section will be devoted.

General Considerations continued.—The conditions under which the physician finds his patient run somewhat in this fashion. The patient complains of a feeling of anxiety about the precordia, with a general unaccountable anxiousness—a sense of difficulty of breathing, which is notably increased upon exertion; he has fluttering about the left breast amounting to palpitation upon effort or exercise; the pulse is irregular, or may be regular but compressible; then come a dusky complexion and impeded respiration. Here, then, is a condition of cardiac engorgement which would scarcely be disputed, whether as a passing condition or as one in a series of similar attacks. On examination of the case, there can usually be found a feeling of diffused impulse on palpitation, a large mass apparently being thrown into contact with the thoracic walls; percussion reveals an increased general dullness, frequently in the direction of the right side of the sternum. Auscultation communicates to us the further information that there is a short slapping sound, with or without irregularity, or, perhaps, evidence of laboriousness—a heaving swell with obvious effort, which, however, is not followed as effect by that impression on the arteries we might look for; and, finally, there is a something beyond this utterly undecipherable by words: a peculiar significant information conveyed, which experience and repeated observation alone can understand or interpret. Those who have made heart disease a study will readily understand and supply that which I feel incompetent to convey. Or, in other circumstances, the patient has a tickling cough, feels short of breath on exertion, has a slight attack of bronchitis, or may be no particular ailment; the pulse is small or feeble, but, on casually applying a stethoscope, there is found a state of cardiac excitement with some irregularity in time—action, like imperfect palpitation, but without any evidence on the radial pulse. It is nevertheless there, and percussion soon demonstrates that there is increased dullness to the right side of the sternum, and auscultation reveals corroborative information in adding a marked accentuation of the second sound at the pulmonary valves. The aggregation of sounds demonstrates that there is embarrassment and also laboriousness in the right ventricle; it is not likely to be accompanied by any effect on the radial pulse; and even the discriminating sphygmograph is thrown out, for there is no increased arterial tension anywhere where it can be applied. The trouble is going on in the right side, the diminished amount of blood passing into the left ventricle is insufficient to allow any impression to be made on the arteries even if, as is very probable, the left ventricle is acting somewhat excitedly. From the number of fibres which belong equally to the right and left ventricles, and can be traced into each (see the works of Searle and Pettigrew), such community of action, even where there is no call on the left ventricle, is almost unavoidable. These conditions, and more so the latter one, are common enough when searched for, especially among the out-patients of a public institution; in fact, we are learning that a condition of engorgement of the cavities of the heart is quite usually met with; and, in fact, if we are to believe M.M. Cyon, von Bezold, and Claude Bernard, a special innervation is in action to permit it. How far this condition may be a necessary one in the present state of science, we are unable to determine; we can, however, readily discover this condition, and more easily calculate the amount of mischief which

is actually present therefrom, or likely to result from its continuance. Without entering here into the troubled waters of a consideration of the existence and importance of a condition of temporary distension in acute disease or passing conditions, which is reserved for a later section, we are familiar enough with this condition when fully established as dilatation, with or without hypertrophy. A permanent enlargement of the ventricular cavities, and more commonly so of the right one, is a condition the reverse of rare. While frequently found among persons advanced in life, it is far from uncommon among younger people. These are the conditions which physiological research has pointed out as suitable for the administration of digitalis as a therapeutic agent; and clinical observation confirms the view. It is proposed, then, to consider the general condition of distension or dilatation; the manner in which the drug acts; the other conditions, causal or consequential, with which the condition is connected; and the especial circumstances in each condition which would encourage or forbid its use.

Mode of Action in Distension or Dilatation.—It is in this condition of distension that the advantages of the administration of digitalis are most evident. In this condition of deficiency of expulsive power, the heart-walls yield. The heart is distended, and in contraction only gets rid of a little blood off the top, remaining more or less full in systole. It is more or less full before the distended auricle and veins behind pour in their contents under the increased pressure of distension. It is in the partially filled condition of the ventricle that the difficulty lies essentially. If the ventricle were not partially full, the auricle and veins would be somewhat relieved; but there is what would fill well an empty ventricle waiting to be discharged into one more or less full to begin with. The action may be moderately regular on quiet being maintained, but it is at once disturbed on motion, especially if this be at all active; and then we get palpitation and irregularity, or even intermittency, the regular action being again restored by quiet. There is a constant contest going on between the stimulus of the contained blood and the inhibitory action of the pneumogastric fibres. The distension excites the muscular walls to overcome the restraining influence; for, without the stimulus of distension, the walls could never overcome the inhibitory action of the pneumogastric, the *vis inertiae* of the blood to be driven; and action still further deranges the balance by making still greater calls on the muscular walls. In fact, the heart is in a state of over-distension, and in a condition both analogous to, and homologous with, an hypertrophied bladder attempting to overcome the obstruction of an enlarged middle lobe of the prostate. The over-distension goads the organ to such a contraction as shall relieve that over-distension, but only so far, and no further; there is no complete contraction. An incessant play goes on between the condition of over-distension and the restraining fibres of the vagus; the balance between the muscular walls and their work remaining confessedly disturbed. In this condition, the administration of a drug whose physiological action is to stimulate the sympathetic ganglia, and thus the muscular fibres under their control, into excessive contraction, is almost the only means of restoring the equilibrium. This is beautifully exemplified in the heart of a frog, when paralysed and almost brought to a standstill in diastole by aconite; the heart is distended, globular, and, in every respect but that of chronicity, in the condition of a dilated or distended heart. Then administer digitalis, and watch the result. The distended globe, just pumping painfully a little off the top of the contained blood, and that at long and irregular intervals, begins to contract with more vigour; each ventricular systole is more and more complete; and the bulk of blood remaining unexpelled—and that is the great point—becomes less and less in quantity. Shortly, the distension in diastole is shortened, the distension and contraction come gradually back to the norm, the irregularity in time is lessened, and a complete restoration results. But if the experiment be carried still further, spasmodic contraction or the condition of concentric hypertrophy sets in, irregularity again makes its appearance—for the balance is now disturbed in the opposite direction; in fact, the symptoms of digitalis-poisoning are brought out, and ultimately the heart is brought to a permanent standstill in systole. Thus in a distended heart, only a longer time is requisite, and, of course, the cause of the original distension must be overcome; so that the conditions are scarcely equal, and longer time and an artificial compensatory hypertrophy is necessary to maintain the balance thus temporarily restored. When this condition of distension is only of short duration, as seen in people who have been overworked and overtaxed for a short period only, but presents all the appearances, signs, and symptoms of cardiac dilatation, the restoration of the natural balance by digitalis may be quick and withal permanent. Certainly I have seen such cases. The experiments of W. T. Gairdner on Groux, the man without a sternum, show that the ventricular chamber undergoes a certain amount of expansion under passing circumstances, a normal distension in fact; for distensibility without abolition of function is a peculiar property of

involuntary muscular fibre; but when distension is excessive, or the tissue degenerate, however, abolition of function may, and certainly does, take place. The experiment may be tried on any thin muscular man—viz., place the tip of your finger on the exact apex-beat, and bid him hold his breath; the right ventricle dilates until the apex-beat is lost behind the distended ventricle, which acts like a water-cushion between the left apex-beat and your finger. Still keeping your finger in its place, tell the man to breathe again; the distended condition passes away, and soon no trace of it remains. Now, all the time the heart has been beating away, and there has been no abolition of junction. Claude Bernard has gone so far as to suggest that a normal distension of the heart takes place through the action of the depressor nerve of the heart of Cyon and Ludwig, and that the heart can undergo a certain amount of accommodation to the blood-vessels, and by dilatation become, for the time being, a regulating reservoir. Without endorsing the theory of Claude Bernard, it must certainly be admitted that the condition is unquestionably common enough, and is not detected because, probably, it is not sought for: it is intimately related to the short, weak, fast pulse, which in a remarkable manner is rendered slow by digitalis, with great improvement in the systemic symptoms. Now, what has gone on? The condition is one of distension; the ventricle, just at the point of distension always, from inefficient contraction, soon becomes so over-distended as to be excited to contraction in spite of the vagus; the pulse-wave is feeble, for only a small quantity of blood is thrown into the aorta, and the elastic walls are not sufficiently distended to bring out a good pulse; the needs of the circulation are not properly supplied, and the body generally partakes of the feebleness of the circulatory centre. Then administer digitalis, and soon the pulse falls, say from 130 to 72; the radial pulse is much improved, being fuller and more sustained, and relief of the system is attained. Sometimes, but rarely, we read of a curious irregularity of rhythm accompanying the alteration, viz., sometimes a series of beats at the rate of 130 per minute, and then another series at the rate of 72; it seems as if it were some time before the old habit was broken. Never having met with such a case, I cannot explain the condition. The slow pulse is due to the ventricle making a more complete contraction, taking up, of course, more time over it, and requiring longer time for distension again. In fact, to again use our old simile of the bladder, the condition of distension is like the bladder behind the enlarged prostate, only contracting to the extent of over-distension—soon full, because never empty; while the altered condition bears more resemblance to the normal bladder capable of complete contraction, and consequently requiring longer time for distension. The heart in distension is incessantly at the point of over-distension, and is acting unnaturally quickly; the administration of digitalis, by producing more perfect contraction, relieves this condition of irritable, or, rather, irritated distended ventricle, while, at the same time, more complete contraction produces more thorough aortic distension, and thus brings out more thorough arterial recoil or systole; that, again, gives relief generally to the systemic symptoms, and also permanent benefit as an ulterior result. It must be borne in mind here that the contraction of the ventricle fills the vessels and distends them; the recoil of the elastic arteries completes the propulsion of the blood. The series of altered actions consequent upon increased contraction, run in the following order or sequences; and it may be desirable for the sake of lucidity to arrange them in a series of propositions, each depending on the one before, like a logical syllogism. The effects of increased contraction are, then:—

1. Increased arterial distension and tension, which give relief to the systemic symptoms, and further causes
2. Increased arterial recoil. This is the propelling power for the coronary arteries; and thus arterial recoil means
3. Increased or improved coronary circulation; and that, in its turn, produces
4. Increased nutrition of the heart, which results in
5. Compensatory hypertrophy. In connection with these, we have also to consider
6. Atheroma and fatty degeneration of the heart-fibres.

[To be continued.]

PLUGGING THE NOSTRILS AS A PRECAUTIONARY MEASURE.—M. Verneuil, in a paper published in the *Bulletin Général de Thérapeutique* for May 30, recommends plugging of the posterior nares as a precautionary measure in all cases of operation on the face where there is danger of the passage of blood into the pharynx. Besides preventing this as long as the soft palate is uninjured, the plugging also, M. Verneuil says, enables chloroform to be given during the whole operation. It ought to be done before the induction of anaesthesia is commenced.

HOW TO REFORM OUR PROFESSIONAL GRIEVANCES.*

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GENTLEMEN,—By accident rather than by my deserts I find myself in the honourable position of President of the Midland Branch of the British Medical Association. It is impossible that any one can forget—least of all that I should not be painfully conscious—that one who has gone to his rest was elected by you to preside on this occasion. Mr. S. W. Fearn occupied a first position in the profession in this locality; and no less for his ability as a surgeon than for his sterling worth and high professional character, we all should have rejoiced to see him in the Presidential Chair. An all-wise Providence has decreed otherwise, and upon me, by your favour, has devolved the difficult and almost impossible task of worthily succeeding him.

I crave your indulgent hearing of the remarks that follow. They are the result of much earnest thought, and, so far as they shall be worthy of your acceptance, are the outcome of conversations that I have had with many of my seniors. Throughout my professional life it has been my happy privilege to be thrown much among my elders, and with them I have frequently discussed questions which, for lack of a better term, I may call our "professional grievances". I venture to think that our time will not be misspent if I take up some of these grievances and invite you to look at them in their different lights, and ask you to consider whether the day has not arrived for us to get rid of some of them. If, with your assistance, I succeed only so far as to break the ground for future more skilful cultivation, we shall not have met in vain. Who is there among us that has no grievances? Is the parish-doctor free? or the club-doctor? or the general practitioner? or the physician? There are not wanting those who feel it something of a grievance that there should be this classification. Why should the title of "Physician" be restricted to a few? or, if restricted, be a more honourable one than any of the rest? I for one, as one of the privileged class, am quite prepared to see the distinction removed, if only the levelling be a general upraising, not a general depressing, of the profession. In the work of attending upon the poor as a servant of the state, still less of attending on the poor under an arrangement made by themselves, as the fruit of their own forethought and self-dependence, and in the arduous and responsible duties of "family doctor", there is no necessary inferiority. The physician who says that there is, does not know the true dignity of his own position. But we are dealing with things as they are, and are, therefore, accepting these distinctions merely for convenience of illustration.

Accordingly, I begin with the parish doctor, subject to the control of men who, to a proverb, "have no idea beyond that of keeping down the rates". There are, no doubt, honourable exceptions in Derby, perhaps, and elsewhere, which will occur to every one; but none know better than parish doctors that a board of guardians is an acknowledged type of parsimony, and exceptions here or elsewhere only serve to make the rule more palpable. From these his masters he receives in many cases scarce enough to cover the cost of drugs; he has, moreover, an acreage of duty so extensive as to make his work impracticable. Yet he is obliged to hold on for fear of leaving an opening for a rival; and after all he gets from the public often not even thanks. There are those among the poor who call him "blessed"; but when the time comes that he wishes to retire from his onerous duties, the public makes little or no sign of gratitude or of sympathy.

Take next the case of the club-doctor, striking a bargain with the committee at the "Fox and Goose". He receives a small capitation fee on each member, with the chance of attending the member's wife and children. This is the bait held out to the young, and too dearly purchased to be given up by the old, though they have long since found out the truth of the proverb, "All is not gold that glitters". The capitation fee is to include everything—no extra fees, no charges for physic, no protection against the admission of well-to-do tradesmen, small farmers, with the publican himself, at whose house, and for the good of whose house, the club meets—of many, in short, who join the club for nothing else than to be able to claim medical attendance and physic at a nominal cost when they are sick. And, worst of all, to an honourable, high-minded man, there is the degradation of being in the eyes of the public, of the profession, and of even the members themselves, "only a club-doctor".

But leaving these the so-called lower ranks of the profession, how fares it with the general practitioner—the man who perhaps eschews parish work and will not condescend to club-practice?

* President's Address, delivered at the annual meeting of the Midland Branch, 1871.