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REFLEX ACTION AS A CAUSE OF DISEASE AND MEANS OF CURE.

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As a préliminary to the paper of this evening upon reflex action as a cause of disease and a method of cure, I must say a word about reflex action itself, and also about another subject with which it is very closely connected, viz. the transference of impressions.

Reflex action is the effect produced by an impression made upon a sensory nerve, transmitted by that nerve to a nerve-centre, and reflected or thrown back along a motor nerve in much the same way as we may imagine the force to be which is applied to one end of a string running over a pulley and transmitted in a different direction by the other end to produce a certain effect. If we fancy the further end of the string to be divided into several strands, each of which is attached to a different object, and which may be, separately or together, affected by a pull on the nearer end of the string, we shall form a still more definite notion of reflex action, for an impression made upon the same sensory nerve may produce various results, according to the strength of the impression

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and the efferent nerve channel along which it is thrown back by the nerve-centre. An impression made upon a sensory nerve, for example, may produce motion of either a voluntary or involuntary muscle, or may affect the nutrition of a tissue. Under the head of involuntary muscles we must class the muscular fibres of the vessels, and those vascular changes which in themselves play a great part in nutrition and secretion may be very greatly influenced by impressions made upon sensory nerves. The way in which we know that the nutrition of a tissue may be influenced reflexly apart from the changes in the vessels is, that observations on the submaxillary gland have demonstrated that we may, under certain conditions, obtain vascular changes without the secretion which usually accompanies them, and that, *vice versâ*, we may obtain secretion without the vascular changes which ordinarily accompany it. Thus, on stimulating the nerves of the tongue, the impression which we make is usually transmitted by the fifth nerve to the brain, and is thence reflected down the chorda tympani to the submaxillary gland. There it induces dilatation of the vessels, and free secretion of saliva from the gland; but if we administer atropia we do away with one of these results, while we leave the other as it was—we completely arrest the secretion, but we allow the vessels to dilate as before. If, on the other hand, we employ physostigma, we contract the vessels, but cause great secretion, such secretion as is usually accompanied by dilated vessels and the free flow of blood through the gland. It is evident, then, that vascular changes, although usually associated with alterations in nutrition, do not necessarily cause them; and that, in the gland we have just mentioned, changes in the tissues composing it will occur without the calibre of the vessels or the flow of blood through them undergoing any material alteration.

We will now say a word about the transference of impressions. Just as we may imagine the further side of the cord passed over the pulley to be divided into different strands, while the nearer side is single, and as we imagine different results obtained by pulling upon the single string by reason of those subdivisions at its further end, so we may have the

nearer end of the cord subdivided into strands, while the further end is single, and thus we can obtain a similar result by pulling any one of the strands on the nearer end. This simile may serve to illustrate the way in which we may obtain a similar result by irritation of various efferent nerves, the stimulation being conveyed to the nerve-centre and reflected down the same efferent nerve in each case. For example, a small grain of sand in the eye will cause a person to wink violently and involuntarily. In this case the impression made upon the sensory nerves of the conjunctiva is transmitted up to the brain, and reflected down the motor nerves of the orbicularis palpebrarum. But some time ago, after the extraction of a tooth, and while the wound in the gum was healing, I observed a twitching of the corresponding eyelid somewhat resembling that which would have been caused by a grain of sand in the eye. Here, also, we have the motor nerves of the orbicularis reflexly excited, but the strand, if we may so term it, through which the stimulus was sent up to the nerve-centre was not the same, for in this case it was a dental, and in the other case an ophthalmic branch of the fifth. With these general remarks on reflex action and transference of impressions, we will now proceed to consider some cases in which reflex action is a cause of disease. I have just mentioned one instance in which intermittent spasm of a voluntary muscle, the orbicularis palpebrarum, was caused by irritation of a sensory nerve. This leads me to remark that a very important condition to be borne in mind is that constant stimulation of a sensory nerve will often produce clonic or intermittent, and not tonic or continuous, contraction of the muscles which it may set in action. It was observed by Nothnagel that if the sciatic nerve of a frog's leg was subjected to constant stimulation under certain conditions, the contractions which it induced reflexly in the other leg were intermittent or spasmodic, but not continuous or tetanic. Another instance in which voluntary muscles are reflexly affected is seen in the acts of coughing and vomiting. Coughing is adapted for the purpose of expelling irritating substances from the respiratory passages, and thus preventing their injuring the organism, just as the act of winking is adapted to remove injurious

substances from the eye. Coughing is usually excited by irritation of the nerves of that part of the body from which the irritant is to be removed. But coughing, like winking, may be reflexly induced by other nerves than those which usually excite it, and thus may prove hurtful instead of useful. Thus, in pleurisy, irritation of the pleura causes the same expulsive efforts as a foreign substance in the bronchi, although those efforts can expel nothing, and only cause pain to the patient; and even when the act of coughing is induced from the ordinary nervous channels, but where the irritant, like tubercle in the lungs, cannot be removed, the act is likewise injurious. In the same way, vomiting is most frequently induced by the presence of irritating substances in the stomach, and proves useful by causing their rejection and thus relieving the stomach of their obnoxious presence. But when the irritation is due to inflammation of the walls of the stomach itself, the expulsive efforts of retching are quite useless, and only exhaust the patient. Here, too, the act of vomiting can be induced by irritation of other nerves than those of the stomach itself. Irritation of the pharyngeal branches of the glosso-pharyngeal and of the pulmonary branches of the vagus, irritation of the hepatic nerves by the passage of a biliary calculus, irritation of the renal nerves by a calculus resting in the kidney or passing down the urethra, irritation of the intestinal nerves (as, for instance, by incarceration of a hernia), irritation of the uterine nerves by the presence of a foetus in the womb, or of the ovarian and vesical nerves by inflammation of the ovaries or bladder, may all produce vomiting; and in all, or nearly all, these cases, efforts at emesis will be productive of no beneficial result. When the irritation is further down the intestine, as when an ulcer is situated in the rectum, there is a constant desire to go to stool, but the only results of the expulsive efforts involved in its gratification are exhaustion of the patient and aggravation of the ulcerated condition. In the efforts of micturition, as in those of vomiting and defecation, we have combined movements of voluntary and involuntary muscles. The urine is retained in the bladder by the contraction of the sphincter surrounding its neck, and it is expelled by contraction of the body of the bladder itself with

the assistance of the abdominal muscles. Both the sphincter of the neck of the bladder and the muscular walls of the organ itself may be reflexly excited to contraction, and we may thus have reflex incontinence or reflex retention. One of the most common causes of incontinence of urine, for example, is the presence of ascarides in the rectum; and while the ascarides remain, we may employ drugs to cure the incontinence without success. An interesting case is described by Mr. Teevan in the *Practitioner* for Oct. 1876, where a boy had been treated in vain by medicine, but was at once cured by healing a fistula *in ano* from which he had been suffering, the irritation produced by it appearing to have been the real cause of the incontinence.

We will now pass from reflex changes in the respiratory and intestinal tracts, to reflex changes in the blood-vessels and heart. It is well known that, usually, irritation of a sensory nerve causes dilatation of the vessels in the part supplied by that nerve, and contraction of the vessels in the other parts of the body. This may take place without any alteration whatever in the beats of the heart itself; but if the irritation be very strong, or applied to certain nerves, the heart also may be acted upon. There seem to be certain nerves which act more readily upon the heart than others, and more especially is this power possessed by the fifth nerve, the roots of which are very closely associated with those of the vagus. On stimulation of the branches of the fifth nerve passing to the nose in animals—as, for example, by holding ammonia, strong acetic acid, or chloroform before the nose of a rabbit—the beats of the heart may be suddenly and completely arrested. To a similar arrest of the cardiac pulsations by irritation of the dental branches of the fifth, I attribute the numerous deaths which have occurred through the extraction of teeth under chloroform. It is probable that the extraction of teeth would, under all circumstances, be an exceedingly dangerous operation, were it not that in the waking condition irritation of the dental nerves sets in motion two pieces of mechanism, one of which, to a great extent, counteracts the effects of the other. As I have already mentioned in a former paper, I was once asked how it was that the application of ammonia or acetic acid to the nose of a

fainting person was proved by experience to be beneficial, when theoretically it ought to be injurious by arresting the already enfeebled heart. The answer to this is, that ammonia or acetic acid, held before the nose of a fainting person, by irritating the branches of the fifth nerve, does not act upon the heart alone—it causes contraction of all the vessels of the body, and thus keeps the arterial system full, and the blood-pressure high, despite the diminished current poured into it by the flagging heart. So much is this the case, that I have found in an animal in which the heart was weakened and the vessels dilated by shock, that the application of ammonia or acetic acid to the nose raised the pressure by one-fourth of the whole. In the ordinary waking condition, the sudden stimulus of extracting the tooth has its effect upon the heart completely counteracted by the coincident contraction of the arterioles throughout the body which it also causes. In chloroform narcosis, however, these two reflexes are not influenced equally by the drug, and the reflex upon the heart may remain after the reflex action upon the vessels has been abolished, so that the heart may stop, and death will then ensue, for, the capillaries being no longer contracted, the blood at once drains out of the arteries into the veins, and circulation ceases. Another very important reflex upon the heart is that which is effected through the solar plexus and the sympathetic nerve. A stroke upon the belly will through these nerves stop the heart, dilate the vessels, and induce the most serious conditions of shock, killing the patient, or at any rate bringing him down to death's door. The most important nerves through which the vessels are reflexly contracted are the splanchnics, and the contraction of the abdominal vessels which they supply has much more effect in altering the general pressure of blood throughout the arterial system than the contraction of any other vascular district in the body. But although the abdominal vessels are the chief ones concerned in alterations of blood-pressure, yet local alterations in the various organs may have an even more powerful action upon the nutrition of these organs themselves: for it is probable that although the abdominal vessels may be caused to contract by powerful stimulation of almost any sensory nerve yet that the blood-vessels in different organs

of the body—such as, for example, the kidneys or mucous membranes—are more affected by irritation of some nerves than of others. The researches of Sanders-Ezn have shown that stimulation of certain sensory nerves, or of limited districts of the skin, will induce definite muscular action due to contraction of limited groups of muscles. It is probable that irritation of limited districts of the skin also induces contraction of limited groups of involuntary muscular fibres or of limited districts of vessels. It is well known that tonsillitis is much more frequently produced by exposure to a draught which strikes the back or side of the head than by a current of air meeting one full in the face, or even by long-continued exposure to a storm in the open air. The cause of this has not yet been satisfactorily ascertained, but it has been attributed with some probability to irritation of the nerves of the ear by the cold current of air. When the throat is irritated, the irritation is not unfrequently felt in the ear; and *vice versa*, it seems probable that irritation in the ear may cause alterations in the throat. It has been observed that pressure upon the floor of the external auditory meatus in a person who had suffered from otorrhœa produced violent or uncontrollable coughing; and if irritation of the ear thus produces a motor reflex like that of irritation of the larynx, it seems probable that it may also produce a reflex trophic disturbance similar to that which would have followed the direct application of an irritant to the larynx.

Congestion of the kidneys in horses is caused by exposure of the loins to rain, the action of cold upon that district of the general surface having a peculiar effect upon the kidneys, not produced by its application to other parts of the body. It is stated by Sidney Ringer upon Brown-Séquard's authority that blistering the loins will cause contraction of the vessels of the kidney, but I have not been able to verify this quotation. But though there seems to be a peculiar relation between the loins and the kidney, the renal circulation would appear to be affected by other nerves. Thus, for example, in a case narrated by Dr. Griffith at a meeting of the Medical Society of London, albuminuria was produced by the application of a dressing to an anal fistula, which ceased when the dressing was

removed, and again appeared on its re-application. In this case, the vessels of the kidney seem to have been reflexly affected by the irritation applied to the anal nerves to such an extent as to produce albuminuria, although probably no organic disease of the kidneys themselves was present. Exposure of the abdominal walls to rapid changes in temperature may bring on diarrhœa, as the natives of India well know. It is possible that in these instances the cold acts through the abdominal walls upon the intestines themselves; but it seems also highly probable that some part at least of the action is reflex from the surface of the abdomen. Whatever the cause of it may be, however, it may be guarded against by wearing a cummerbund, like the Hindoos; and it is well for persons who are subject to diarrhœa to wear, even in this country, a warm woollen or silken belt around the abdomen.

Irritation in the intestines may induce, not merely vomiting and diarrhœa, but even general convulsions, and cases are on record of epileptic fits having been produced by the presence of a tapeworm in the intestine, which ceased upon the expulsion of the intruder. Hysterical fits, although their pathology is far from being understood, are now becoming to some extent associated with ovarian irritation; for it is found that, in many cases of hysteria, the ovaries are tender upon pressure, and that the hysterical fit may frequently be instantaneously arrested by pressing upon the ovaries.

We have, so far, been dealing chiefly with reflex action as a cause of disease, but now we must say a word or two respecting the transference of impressions. It is well known that persons who have had their legs amputated often complain of cold feet, or of pains in their toes, on change of weather. The irritation here is really in the end of the divided nerve in the stump. But the brain is accustomed to refer all impressions made upon a nerve during its course to the terminal filaments from which impressions usually come, just as we feel a tingling in the fingers when we pull upon or jar the ulnar nerve, or, as it is popularly termed, the funny bone. In disease of the hip, the irritation is felt, not so much in the hip itself, as in the knee.

In headaches one can frequently trace the origin of the pain

to some point at a distance from the aching part. Some years ago I met with a case which was to me very instructive. A woman complained of a headache situated in the left temple. One of her teeth at the same time ached somewhat, and I gave her a pledget of cotton wool, dipped in solid carbolic acid, to put into the cavity. To my disappointment, it had little or no effect; but five minutes afterwards, on the removal of the cotton wool to the cavity of a second tooth, likewise decayed, but which had not at first been suspected as the cause of the mischief, the pain disappeared entirely from the temple. Some time afterwards, I was led to discover an unsuspected decayed spot in one of my own teeth, by a headache in the temporal region. I had noticed that during these headaches there was generally tenderness over the aching part, and that there was also a tender point at some little distance, usually the eye, which was tender to pressure. On this particular occasion, however, there was no tenderness of the eye, and I felt all along the side of the cheek and under the jaw to see if I could discover a second tender spot. Under the ramus of the jaw I found a small gland, painful on pressure. As glandular irritation almost always indicates something wrong in the lymphatics which pass to the gland, I at once suspected something in the mouth to be the cause of the tenderness. As there was no abrasion or tenderness of the mucous membrane of the mouth or tongue, I took a pointed instrument, and tested each tooth successively. At the very back of the crown of the last molar, I detected a small point which was tender upon pressure, and on going to a dentist I was informed that the point was just beginning to decay. Had it not been for the headache, this would have passed unnoticed, as the tooth itself had, up to that period, given me no inconvenience whatever. Headache over the eyes, although frequently depending on gastric irritation, is not unfrequently caused by straining the eyes, and is only to be removed by lessening the work which these useful organs have to perform. One finds this headache over the eyes in men who work much with the microscope, or in women who are engaged in fine needlework. Yesterday I met a case of this sort in the surgery. This was a woman who had been accustomed to work about her house,

but who began to work at dressmaking three months ago ; her hours of work being from 9 A.M. to 9 P.M., with an interval of an hour for dinner in the middle of the day. About two months ago she began to suffer from headache above her eyes, which makes her sometimes feel quite giddy. It gets worse in the evening about seven or eight. The headache here, it will be observed, came on about a month after the eyes had been subjected to this unaccustomed strain ; and it became worse in the evening after the darkness rendered artificial light necessary, and thus increased the visual strain.

Having said so much on reflex action as a cause of disease, we will now consider it as a method of cure ; and the first instance that suggests itself to our minds is the beneficial effect of a blister. Two theories have been proposed to account for the action of a blister. One is, that it dilates the vessels of the skin in the part to which it is applied, and by thus drawing away some of the blood from the inflamed organ below, lessens the pain and inflammation in it. The other theory is, that the blister acts reflexly upon the organ itself. The first of these suppositions is very improbable, because the amount of blood in the skin covered by a blister is exceedingly small, and, moreover, does not come from the inflamed organ, with which the blistered piece of skin may have little or no vascular action. The second theory is much the more probable one, but it is not yet certain how the vessels of the inflamed organ are affected by the blister. We do not know whether they are dilated or contracted. It is most likely, however, that they are contracted, the contraction lessening the pressure of blood upon the inflamed tissues, and thus diminishing the pain in somewhat the same way as we relieve the throbbing in an inflamed finger, by holding the hand above the head, or by compressing the brachial artery. This is rendered probable by the experiments of Zülzer, who found that when a blister was applied to the back of a rabbit for a length of time the skin and the muscles immediately below it were red and congested, but the deeper layers of the muscles, the pleura, and even the lung on the same side, were pale and anæmic. There are few inflammations of the internal organs in which blisters to the surface are not serviceable, but much has yet

to be done to ascertain the exact points at which they ought to be applied in order to produce their maximum effect. Thus, it is said, that in sciatica a blister to the heel will sometimes afford relief, while one applied in the neighbourhood of the nerve itself has little or no effect.

The effect of poultices is probably different from that of blisters, although ultimately productive of similar relief; for if we again take the simple instance of a finger inflamed in consequence of a thorn having run into it, we find that we can relieve the pain in two ways, either by putting the hand into cold water, or by plunging the finger into a warm poultice. Both of these measures, apparently so dissimilar, will produce a like result in regard to the inflamed point; that is, both will lessen the pressure of blood in the vessels where stasis has already taken place. The cold, applied to the whole of the hand, will cause the arteries leading to the finger to contract, and will thus diminish the supply of blood to the inflamed part, and lessen the pressure in the blocked capillaries. The warm poultice will also lessen the pressure, not by diminishing the flow of blood to the part, but by dilating the vessels around the point of stasis, and affording the blood a ready exit into the veins. In the case of internal organs, the blister applied to the skin probably acts like the cold applied to the finger, while the warm poultice placed upon the surface of the thorax or abdomen affects the deeper lying organs in the same way as it does the superficial ones, the warmth penetrating through the thin thoracic or abdominal parietes. On this account, when we wish to relieve pain in the chest or belly, we ought to make our poultices in a particular way. The common practice of mixing the linseed-meal with hot water, and applying it directly to the skin, is quite wrong, because if we do not wish to burn the patient we must wait until a great portion of the heat has been lost. The proper method is to take a flannel bag (the size of the poultice required), to fill this with the linseed poultice as hot as it can possibly be made, and to put between this and the skin a second piece of flannel, so that there shall be at least two thicknesses of flannel between the skin and the poultice itself. Above the poultice should be placed more flannel, or a piece of cotton wool, to prevent it

from getting cold. By this method we are able to apply the linseed-meal boiling hot without burning the patient, and the heat, gradually diffusing through the flannel, affords a grateful sense of relief which cannot be obtained by other means. There are few ways in which such marked relief is given to abdominal pain as by the application of a poultice in this manner.

Besides blisters and poultices, there is a third class of remedies acting reflexly, which is often too much neglected or despised, but is of exceeding service; I mean plasters. In chronic bronchitis, a plaster on the chest affords great relief, the plaster employed being either the simple pitch one, or the *emplastrum calefaciens* of the British Pharmacopœia. The pain in the chest just under the mamma, which is so often associated with anæmia and leucorrhœa, is relieved in the most remarkable way by the application of a belladonna plaster, and the same application also relieves when the pain is dependent on organic disease of the heart. The pain in the back, also, which is associated with leucorrhœa and uterine disturbances, is greatly eased by the application of a pitch plaster, or by a strip of *emplastrum calefaciens* placed along the lower part of the spine. In place of this, the *linimentum sinapis*, put upon a piece of spongio-piline four or five inches broad and ten or twelve inches long, has recently been recommended by Dr. Gamgee. The cause of the pain in the back is not known, but Dr. Gamgee's theory is that it is due to exhaustion of the lumbar portion of the spinal cord, that part from which the nerves for the urinary and genital organs are derived. In order to repair this exhaustion, he thinks that the supply of blood should be diminished, because functional activity is usually associated with rapid circulation, while the opposite condition of partial anæmia occurs during the period of rest and repair. To obtain this partial anæmia, he employs counter-irritation, differing from that of the blister in being less intense and more prolonged.

Such are a few of the more prominent instances of reflex action, as a cause of disease and a means of cure. To enter fully into all of them would occupy more time than the Society can afford, and to explain them satisfactorily would require more knowledge than I either possess or am able to obtain.