LUMLEIAN LECTURES

ON THE

PATHOLOGY OF THE PNEUMOGASTRIC NERVE.

*Delivered at the Royal College of Physicians.*By S. O. HABERSHON, M.D., F.R.C.P.,
Senior Physician to and Lecturer on Medicine at Guy's Hospital.

LECTURE I.

ONE of the most deeply interesting questions in physiological science is, in what manner the harmony of the different animal functions is maintained. The most delicately adjusted machinery is at work; actions of an entirely different character are performed without interfering the one with the other, and the result is recognised and expressed by the term *health*. The body is a microcosm; and, as in the external world there is harmony in the working of natural forces, so in man's organism there is an adjustment of forces, an even balancing of the living power in its functional integrity, so that, with diversity of operation in the several parts, there is unity in the complex whole. The light of the sun exerts its silent but irresistible power on the vegetable life of the globe, and the plant, and flower, and tree, grow and thrive as if Nature were alone for them. The chemical force in the plant is in operation, and the physical forces are ever in exercise; but the same light has equal power on animal organism; the heat and life go hand in hand, and move on undisturbed, and chemical and physical and living forces are found in correlative action: but not less powerful is the same influence of the sun upon the physical world, upon the waters of the ocean, in producing evaporation, in determining the currents of the sea, and in regulating the winds. But there is wonderful harmony in the adjustment of these different spheres of operation, the vegetable kingdom with the animal, and these with the physical conditions by which the one and the other can exist and flourish.

The functions of animal life are equally diverse. Respiration is a function separate in itself, to ensure the admission and expulsion of air, for the purification and oxidation of the blood: it has its system of muscles and nerves, and adjustment of force. So also is that of the circulation of the blood, the central organ of which is the heart, a living, active, propulsive engine, by which the vital fluid is propelled both into the lungs and into the whole system. Equally distinct is that of deglutition and digestion, by which food is prepared and dissolved, and then absorbed into the circulatory system. Each of these functions—that of the respiration, that of the circulation, and that of digestion—act independently, but still in unison. If one or other be disturbed, the whole system is thrown into disorder. Like the apparently complex mechanism of a locomotive engine, the disarrangement of one valve or one connection will interfere with every part, and bring the power to a stand. In physiology, it is only a small part of the science to study *one* structure and *one* function: each must be taken in its connection with the whole; and so in pathological science. Few diseases can be regarded as strictly local in their character, and the morbid processes in one part are inseparably connected with those which take place in another. The union may be one of structure or of function; the connection may be by means of the supply of blood or the supply of nerves. If we would rightly know the diseases of one organ, we must be acquainted with those which have functional relationship with it. The pneumogastric nerve is a regulating medium, a bond of union between parts which are otherwise dissociated, separate in structure and in function, but united in the healthy working of the body. It holds in check structures which would individually act, but which without it would never harmonise.

I have ventured to submit some remarks on the Pathology of the Pneumogastric Nerve, because there are some questions respecting it which have not received the attention which they deserve, and there are some clinical aspects of disease which are essentially connected with disturbance of the functional integrity of this nerve. In the animal economy, the pneumogastric nerve stands pre-eminent; the functions of the body with which it is connected are of the greatest importance for the maintenance of life, for it is connected with respiration, with

circulation, and with digestion. These three most important functions are guided and controlled by this nerve, and to effect these purposes its distribution is very extensive, and its relations of the most complex kind.

Before speaking of the pathology of the nerve, it will be well to review very briefly its anatomical distribution and its physiological action. The nerve appears at the base of the brain, at the side of the medulla oblongata and front part of the restiform body, and behind the olivary. At this part it is in close proximity with the glosso-pharyngeal and with the spinal accessory nerves. The nerve passes through the medulla in the direction of the floor of the fourth ventricle, where several enlargements or nuclei are observed, which are connected with the nerves having origin at this part. The root of the pneumogastric is in the closest relation with the origin of the hypoglossal nerve, the nerve of the tongue; with the fifth nerve, the sensory nerve of the face, and of the orifices of the nose and mouth; with the seventh, that supplies the muscles of the face; with the glosso-pharyngeal, the nerve of the throat; and with the spinal accessory nerve, an important nerve of respiration. There is the most intimate connection between the nerves at this part, the fifth and seventh, the hypoglossal, and the glosso-pharyngeal, spinal accessory, and pneumogastric nerves. "The fibres of origin of the vagus and glosso-pharyngeal nerves pass through the sensory portion of the fifth" (Carpenter's *Physiology*, 7th ed., p. 558). The beautiful sections made by Lockhart Clarke show the varied unions of the origin of these nerves. The latter author states (*Philos. Trans.*, pt. i, 1858) that "the vesicular column that gives origin to the accessory nerve, after reaching the surface of the fourth ventricle, as the nucleus of the vagus sinks beneath the auditory ganglion, and, diminishing in size, becomes part of the nucleus of the glosso-pharyngeal nerve". It is here that the sensory or afferent impressions brought to the centre are reflected by the nerves of motion, which arise at the same part. As the fibres of the pneumogastric emerge from the brain, they pass to the jugular foramen (foramen lacerum basis cranii), where the nerve is surrounded by the same sheath of dura mater as the spinal accessory, and by the same layer of arachnoid membrane, but separated from the glosso-pharyngeal. In the foramen is a ganglionic enlargement, and there are connections, as described by Quain (*Anatomy*, 8th edition, vol. i, p. 559) with the facial, with the spinal accessory, with the petrous ganglion of the glosso-pharyngeal, and with the sympathetic. Half an inch lower down is a second ganglion of the pneumogastric, which is said not to include the branches of the spinal accessory sent to join the vagus; but the ganglion communicates not only with that nerve, but with the hypoglossal, the first two spinal, and with the upper ganglion of the sympathetic. The branches of the spinal accessory sent to join the pneumogastric, after leaving the foramen, may serve to explain the conflicting opinions of physiologists in reference to the motor fibres of the nerve. The spinal accessory nerve is in this way traced to the motor nerve of the larynx and to the palate, and is regarded as controlling the movements connected with vocalisation.

The first branch is the *pharyngeal*, and it arises from the upper part of the trunk, and, uniting with branches from the glosso-pharyngeal, the superior laryngeal, and sympathetic, forms the pharyngeal plexus, from which branches are distributed to the muscles and to the mucous membrane of the pharynx.

The *superior laryngeal* is the sensory nerve of the larynx, and is divided into an external branch and an internal. The former branch is of great importance, inasmuch as deglutition and respiration require to be adjusted, otherwise food might more frequently pass into the larynx. It supplies the crico-thyroid muscle, the lower constrictor, and thyroid body, and sends a branch to the pharyngeal plexus. The explanation given by Mr. Hilton in reference to this muscular supply is, that the larynx is prepared for the more delicate contractions due to the supply of branches from the recurrent nerve. The internal laryngeal supplies the mucous membrane of the larynx, the vocal cords, the epiglottis, and the base of the tongue; and it sends filaments to join the recurrent nerve.

The *recurrent* nerve is the motor nerve of the larynx, supplying its muscles, with the exception just mentioned; and it supplies branches to the trachea, the œsophagus, the mucous membrane of the pharynx, and also communicating filaments to the deep cardiac plexuses and to the superior laryngeal. These are well shown in the drawing, made from a dissection of mine many years ago. The next branches of the pneumogastric are to the cardiac plexus, and then to the pulmonary; afterwards, upon the œsophagus we find the œsophageal plexus—plexus gulæ; thence it passes through the diaphragm into the abdomen. In the abdomen, numerous branches are distributed to the walls of the stomach. Here again I may refer to some dissections of my own. The nerve joins the large sympathetic ganglion, the semilunar; branches may be traced to the liver, to the duodenum, to the ganglion

on the vena cava, by which it is brought into connection with the phrenic. This connection of the pneumogastric and phrenic nerves is of great physiological and pathological interest. This dissection of mine shows the phrenic distributed to the diaphragm; and afterwards its union with both the pneumogastric and sympathetic nerve in a ganglion upon the vena cava. The diaphragm is the most important muscle of respiration, and is thus brought into harmonious action with the lungs by means of the pneumogastric. The same muscle has to do with the passage of food through the end of the oesophagus into the stomach—the closing act of deglutition. We find evidence of this connection in the spasmodic action of the diaphragm in hiccough, and we recognise it in the attempt to maintain the greatest quietness in the muscle during acute disease of the abdomen; so also in the intimate connection of disease immediately below the diaphragm with the pleura and the lung above it. In gall-stone and other diseases of that kind, we often find pleuritic disease at the same time. Branches of the pneumogastric also may be traced to the pancreas, to the suprarenal capsule, and to the kidney, beside uniting with the sympathetic branches upon the aorta.

Such is the extensive distribution of the pneumogastric nerve; and, before speaking of the pathology and the morbid conditions due to altered nerve-supply, we must very briefly refer to the physiology of the nerve. The nerve is of a double character, and contains both afferent and efferent fibres. It regulates the *respiratory* function. It is the minute afferent branches from the pulmonary plexus of this nerve that reach the structure of the lung and bronchi; and the impressions there received are transmitted to the brain, and are followed by reflex movements. By its connection with the fifth and seventh nerves, the entrance of air by the mouth is regulated; by means of the hypoglossal, the tongue is adjusted so as not to interfere with the free passage of air; the glosso-pharyngeal and external branch of the superior laryngeal bring the pharynx into right sympathetic action; the internal branches and the recurrent regulate the glottis; and the muscles of respiration supplied by the spinal accessory, the phrenic, and branches of the spinal nerves, complete the respiratory act. The important nerve-centre of this function is at the origin of the pneumogastric at the floor of the fourth ventricle. It is the minute branches of this nerve which, distributed to the bronchial tubes, produce constriction and narrowing of the tubes, so painfully manifested in spasmodic asthma. According to Rosenthal, the superior laryngeal nerve has inhibitory action upon the movements of respiration and upon the diaphragm, and acts centripetally on the brain; and Burkart has shown that the inferior or recurrent nerve exerts similar power.

Another important function which is controlled by the pneumogastric is the process of *deglutition*: the movements of the oesophagus are accelerated, and the cardiac orifice may be closed by it.

Still more important is its influence upon the movements of the heart; it controls its movements, and irritation of the nerve retards its action, whilst a strong electric current will stop it in diastole.

The connection of the heart's action with respiration is most important, for the one is essentially dependent upon the other: unless the respiration be performed, the heart will quickly cease, and *vice versa*. The presence of carbonic acid in the pulmonary capillaries—the venous blood having been impelled by the right side of the heart—and perhaps also the deficiency of oxygen in the blood, exert their influence on the minute afferent branches of the pneumogastric, and through the medulla lead to the completion of the respiratory movement.

The supply of the pneumogastric to the organs of *digestion* is essential for the right performance of that function. We have already mentioned that the passage of food in the oesophagus is promoted by the pneumogastric, and so also are the movements of the stomach; the nerve, also, contains afferent sensory fibres, and the irritation of these afferent fibres during digestion causes dilatation of the gastric vessels, according to the experiments of Bernard and Rutherford, and in disease these fibres become acutely active. In an instance of ulceration of the stomach, in which the patient suffered intense pain, I found a large branch of the pneumogastric nerve passing across the floor of the ulcer. (Preparation in Guy's museum.) It is probable, also, that the condition of the pylorus is regulated by the same nerve. Most interesting have been the observations made by Claude Bernard in reference to the action of the pneumogastric upon the liver. By experiment, he found that a puncture of the floor of the fourth ventricle, at the root of the pneumogastric nerve, disturbed the glyco-genic function of the liver, and produced saccharine urine. These experiments have been repeated, and the observations extended, by our colleague Dr. Pavy; but we will not dwell upon them. The connection of the pneumogastric with the suprarenal capsule, with the renal plexus, and the other portions of the sympathetic nerve of the abdomen with the uterus, etc., leads to the reflex irritation of the stomach, so frequently observed in diseases affecting those organs.

Numerous experiments have been made by physiologists illustrating the effect of division of the nerve upon the several organs to which it is distributed. After division, there is loss of sensation in the throat, and foreign substances may pass unheeded into the larynx, a remarkable contrast to the violent spasmodic action produced during the integrity of the nerve; again, after division, there is loss of power in the throat, and of action in the vocal cord; the glottis is partially closed; and, if life be prolonged, the muscles supplied by the divided nerve become wasted; the action of the heart is impeded, at first it is more frequent, and the force is increased; the pulse is larger, because there is diminished tension in the vessels; the lungs lose their sensibility, the movements of the chest-walls are less active, and respiration becomes less frequent but more deep, till it ceases altogether. The capillaries of the lung become filled with blood; the lung is deprived of air; the mucous membrane is congested, and frothy serum exudes into the air-cells; the nutrition of the part is altered, and inflammatory changes are induced. This inflammation is often found where the pneumogastric is injured by pressure. Where the nerve is divided, the cardiac orifice of the stomach does not act, the mucous membrane of the stomach becomes pale, and the secretion is for a time checked, whilst, on irritation of the divided central end of the nerve, the colour is restored. A common effect of irritation of the gastric branches of the pneumogastric is that vomiting is produced, and when the nerves are divided and the peripheral ends are irritated, movements of the stomach are induced (Lauder Brunton); but when these nerves are paralysed, vomiting ceases, and the stomach more easily yields to expansive forces and becomes distended. This condition, we would remark, is very different from those instances in which, from sudden overdistension from gaseous formation and other causes, the muscular coat is unequal to the force required for contraction; the nerve-power is overtaxed, and thereby inoperative.

In considering the diminished power of the pneumogastric in the abdomen, we can scarcely separate its individual action from that in which it is associated with the vaso-motor nerve. In the effects produced by an ordinary bilious attack, or in those consequent on violent vomiting, the afferent fibres of the pneumogastric are in unison with those of the vaso-motor or sympathetic; they are weakened and the vessels expand, at the same time that the cardiac branches sympathise, and the pulse becomes weak and compressible, and the heart's action feeble. After violent vomiting, the secreting power of the liver is interfered with, and the motions become exceedingly pale, at the same time that the nervous supply to the lower lobe of the right lung becomes sympathetically affected. This connection is seen, also, in most cases of inflammation of the stomach; but to this we shall again have to refer. The sudden action of cold water upon the afferent nerves of the stomach may by reflex action stop the heart.

The intimate union of the pneumogastric nerve with branches of the spinal and of the sympathetic nerve may lead to the development of symptoms, as if the branches of the pneumogastric were themselves irritated. We shall subsequently note instances of this reflex action; and a remarkable instance of it is mentioned by Dr. Burdon Sanderson in reference to the fifth nerve affecting the pneumogastric in the rabbit by causing the animal to smell ammonia. "The effect is immediate, according to the strength of the ammonia; the heart is arrested in diastole, or the diastolic intervals may be lengthened. Inhalation of chloroform may stop the heart in the same way". This connection of the fifth nerve is of great interest in some diseases; in hydrophobia, the whole of the branches of the fifth nerve are in a state of intense irritability; the least breath of cold air, merely passing the hand near the face, will induce the most intense spasm of the throat; the branches of the superior laryngeal nerve and of the glosso-pharyngeal are at once acted upon, and so other branches of the pneumogastric nerve. The fifth nerve having acted by its afferent branches upon the medullary centres, reflex action is at once induced. It has been stated that inflammation of the sheath of the nerve has been observed, and also of the cervical nerves at their origin; but these statements require confirmation (Ziemssen's *Encyclopædia of Practical Medicine*). In this terrible disease, we have a condition of extreme hyperæsthesia of these cerebral nerves and their centres; whilst conversely in labio-glosso-laryngeal paralysis we have diminished power of these centres. The seventh nerve is paralysed, and the fifth is weakened; and with these the branches of the superior laryngeal nerve are devoid of sensibility; deglutition is impaired, and becomes a dangerous process, for the natural safeguards are removed. In the clinical wards of Guy's Hospital during the past session, a man with this disease was admitted under my care; his countenance was expressionless, his tongue had lost its power, and deglutition was so difficult that he was fed by the means of the stomach-pump. To relieve his thirst, however, he made the attempt to swallow a draught of milk; the superior laryngeal nerve had lost its sensibility, and some of the

milk passed into the trachea and bronchi. This was quickly followed by a fatal result; and on the *post mortem* table the milk was found in the respiratory passages. In this case, the afferent branches of the pneumogastric failed to excite the sensory centre and to induce the expulsive efforts of violent cough. The afferent fibres of the fifth were also weakened. We have in this latter disease the opposite condition to that observed in hydrophobia; hyperæsthesia in the one, anæsthesia in the other.

The same connection of the fifth nerve with the pneumogastric is found in the effect of severe chill or shock from cold; this reflex action is shown in ordinary sneezing, but it is more decided when the power of the pneumogastric is weakened and severe bronchitis or pneumonia is induced. The shock on the nerve-power of the respiratory organs may be so great that the patient is in a few hours in a state of the greatest prostration, with dry and brown tongue, resulting in advanced fever, but without cough or ordinary external signs of inflammation of the chest. The pneumogastric is almost paralysed; but the first effect was upon the fifth nerve, and a mistake is made in the treatment of these diseases if this connection of the fifth nerve be overlooked. The face should be kept warm, and no draughts of cold air allowed to play upon it. It is quite true that in the perspiration and craving for air in severe pneumonia fanning the face is a temporary relief to the patient, but this is an expression of the exhaustion and of the desire for pure air which the system needs.

We might adduce other instances of the manner in which the pneumogastric nerve is affected by reflex action, but would only here advert to the effect produced upon the centres of the nerve by disturbance on the cerebral aspect of the ganglia. It is powerfully influenced by the emotions and by the passions. The special senses directly influence it; an offensive object, and, still more, a disgusting smell, induce violent retching: sudden alarm at the sight of danger, or the sound that terrifies, at once affects the heart and the respiration, as well as the action of the abdominal viscera supplied by the nerve. The nerve is placed as the custodian of essential vital functions, but it is, as it were, the willing handmaid of the mind and will. We have spoken of its extensive distribution, and each branch of the nerve has, we believe, a definite purpose; and by its means the throat, the larynx, the lungs and the heart, the stomach, the liver, and other abdominal viscera are brought into the closest union. During health, the hidden connections are united in harmonious working; but in disease the jarring of disturbed action spreads its sympathy to all the parts thus linked together. The following laws of action are often observed in the study of clinical medicine.

I. Disease at the origin of the nerve may induce symptoms in any of the peripheral branches; and this reflex state may be one of irritation and hyperæsthesia, or one of diminished power and anæsthesia; the one is spasmodic in character, the other paralytic.

II. Irritation in any set of peripheral branches may produce disturbance in any other part to which the nerve is distributed, or in the centre itself.

III. Alternation of irritation may be induced, at first one set of nerves, then another, becoming implicated. This alternating character of functional diseases is of great clinical interest. We see an irregularity of type and rapidity of recovery which contrast remarkably with the severity of the disease. Spasmodic asthma of the most distressing kind suddenly gives place to disturbance of stomach, this to cerebral symptoms, and these to severe neuralgia. Violent vomiting and marked gastric irritation are followed by loud cough and by loss of voice, indicating that an affection of one set of nerves has given place to change in another set of branches. In general weakness, there is loss of power in all the parts supplied by the nerve, and the fact is often of great importance in the close of disease. In exhaustion, the voice fails; many patients who are suffering from chronic disease are said to die from the supervention of bronchitis or of pneumonia, when the pulmonary condition is really the expression of exhaustion of the pneumogastric nerve; so, also, when there is great weakness, there is greater liability to affections described as bronchitis and inflammation of the lungs, the power of the respiratory centres being lessened, disturbance of nutrition more readily takes place. Still further, when patients are reduced by chronic disease of the stomach, or of the kidney, similar pulmonary changes may be due to exhaustion; this statement is not opposed by the fact of cedema of the lung and broncho-pneumonia coming on from uræmic poisoning.

A further evidence of exhaustion of the pneumogastric nerve is the loss of appetite, and the diminished power in the stomach to digest food placed in it.

[To be continued.]

THE CROONIAN LECTURES ON THE PATHOLOGY AND RELATIONS OF ALBUMINURIA.

Delivered at the Royal College of Physicians.

By W. HOWSHIP DICKINSON, M.D. Cantab., F.R.C.P.,

Physician and Lecturer on Pathology at St. George's Hospital;
Senior Physician to the Hospital for Sick Children; etc.

LECTURE I.

MR. PRESIDENT AND GENTLEMEN,—I propose to bring under your consideration some of the larger facts connected with the several forms of renal disease which are ordinarily characterised by an albuminous state of the urine, marking their pathological distinctions, tracing their points of mutual relationship, and touching upon their associations with changes external to the kidney, or more or less widely distributed through the economy. The types of Bright's disease may fitly engage the attention of the College of Physicians of England. Whether we have regard to the early researches of Wells upon albuminous urine, to the paramount observations of the great physician whose name is inseparably connected with the disorders to which he gave structural place and organic habitation, or to the still progressing inquiries of others, of whom we hope that it may be long before they will take the place which they have earned among the worthies of the past, we are entitled to say, and with no extravagant boastfulness, that the members of our ancient and learned body have taken a part in the development of this branch of knowledge, which more than equals that of all other nations and of all other guilds. And it is appropriate, too, that the successors and inheritors of Harvey should concur, whether as looking from the same point of view, or as co-operating to secure a true figure by regarding the object from different quarters, to add to Harvey's discovery a pathological supplement; and, in working out the changes which disease produces in the circulation, to append to Harvey's propositions a set of corollaries which are among the most important of the results which have sprung from it.

The organic conditions of persistent albuminuria may be broadly divided into three.

1. *Nephritis, Tubal or Diffuse*, the product of simple inflammation of the secreting structure, and of causes directed especially upon the renal function. This, though essentially tubal, may, if intense or long continued, involve the interstitial tissue in the inflammatory process, and supply the granular kidney with one mode of origin. At first localised as strictly as any other organic inflammation, it ultimately tells upon the whole body, and produces in a lesser measure the arterial and cardiac changes which are more largely developed with chronic disease.

2. *The Granular Kidney, or the Kidney of Chronic Interstitial Hypertrophy*.—In this, the fibroid overgrowth has begun as a solitary change, or has been left behind as the more persistent and at last the more prominent portion of a mixed inflammatory process. The general association of this organic state with a morbid condition of the entire arterial system is one of the leading characteristics of the disease, and involves questions which will need a somewhat cautious examination.

3. *The Lardaceous Kidney*, a condition in which this gland participates only in an infiltration which pervades many organs and structures, and is immediately due to a condition of blood in virtue of which it deposits in many arterial districts a material which is different from any of the normal constituents of the body.

The first begins with changes local to the kidney, but often ends in results general to the arterial system; the second is so constantly associated with arterial changes, that it is in dispute whether the renal and the arterial changes are cause and effect, or are simultaneous results of circumstances antecedent to both; the third begins, without question, systematically, producing renal disease only as one of a series of secondary organic changes.

Each of these conditions is broadly separate from the others, but yet has its points of contact with them. Nephritis at first tubal may end interstitially, and thus the large smooth kidney may, however rarely, yet in a recognisable minority of cases, become small and granular. The granular kidney, or the interstitial fibrosis which is its essential, though usually of independent origin, may take its rise in either of the