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RELATION OF THE DEVELOPMENT OF THE GASTRO-INTESTINAL TRACT TO ABDOMINAL SURGERY*

W. J. MAYO, M.D.

ROCHESTER, MINN.

THE RELATION OF ANATOMY TO PRESENT DAY SURGERY

The late Corydon L. Ford, professor of anatomy at the University of Michigan Medical School, was justly considered the greatest teacher of anatomy of his time. I well remember the three years in which I studied anatomy under him, and the impression he made on the students by his clear and forceful presentation of this ordinarily dry subject. He was then a man past middle life; he wore a beard, shaved the upper lip, and because of a congenital clubfoot he walked with a decided limp by the aid of an ivory-headed cane. I speak of these physical factors because they were part and parcel of the man in relation to his teaching. He presented anatomy not alone as a fundamental science which it was necessary to master for the purpose of laying a foundation for clinical medicine, but as a living thing to be considered in almost every professional act. He was closely in touch with the clinical issues of his time, and with anatomy he taught most valuable lessons in physiology and pathology, so that the student gained knowledge of his subject in its relation to his work. The university courses in surgical anatomy were excellent, yet Ford taught us more surgical anatomy than we learned in these special courses, and he also taught us medical anatomy, in order that we might see the patient from the anatomic standpoint, and recognize pathologic deviations from the normal in the early stages. We were drilled in the use of Holden's "Anatomical Landmarks"; I have spent many hours with this little book, going over the living body that I might learn the relation of the external to the internal.

As volunteer assistant I had the further privilege of demonstrating anatomy at the University of Michigan, and the fascination for anatomic detail in relation to medicine and surgery has remained with me. My seat companion was the late Franklin P. Mall, afterward professor of anatomy at Johns Hopkins, and the most distinguished anatomist of his time. Mall was a choice spirit, an anatomist of the research type. On one occasion in showing me the manner in which the heart, by

its peculiar twisting contraction, empties all the blood from its cavities as one would wring a cloth, he remarked that a cavity like the bladder cannot empty itself to the last drop by contractions alone. He said that anatomy since Ford's time had dealt too much with abstract matter. Mall's observation has an important bearing on catheter cystitis, an infection of a small amount of residual urine in an overstretched organ.

During my active experience in surgery, working with many different assistants, I have not always been impressed with their knowledge of anatomy, although all have possessed a fair knowledge of pathology. At times it would seem that they were more familiar with minute pathology than with anatomy. Microscopic histology and pathology, while not overdone, have been allowed to overshadow anatomy and gross pathology—these the surgeon or internist must see with his own eyes if he is to do his best work. It is a question in my mind whether, generally speaking, anatomy is as well taught today as it was in my student days; whether it is taught with a view of instilling in a man a love for the subject, or merely as a foundation for medical practice. I believe this tendency is correctly interpreted by teaching anatomists of the type of Jackson and others, who are taking steps to remedy the existing defects by the better balancing of anatomic teaching. This is also true of the teaching of present day pathologists.

In surgery of the abdomen especially, a wide knowledge of embryology and anatomy is essential. In the olden time when operations were done in late periods of pathologic conditions, and were destructive rather than reconstructive because it was necessary to save life and it was too late to save function, one could fully appreciate the answer of the distinguished surgeon who originated excision of the hip when asked concerning the anatomic details of the operation: "Damn the anatomy; stick close to the bone." Today the bulk of surgery is not done for gross defects but for pathologic conditions which have not deviated from the normal to such an extent that destructive surgery is necessary, but are still in condition for reconstruction. It has been said that the anatomist never made a good surgeon; that it was the pathologist who made the surgeon. This is true only of the vanishing German type. The surgeon of tomorrow must follow in the footsteps of such men as Deaver; he must be an anatomist and a physiologist, and living pathology must hold a greater place in his mind than the pathology which has been developed from the mortuary and has dominated medicine for the past generation.

For many years I have been interested in elucidating problems of surgery of the abdomen. Clinical diag-

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nosis has been notoriously unreliable, and the postmortem does not show the chronic disease from which the patient was sick during life, but rather the particular complication from which he died. Always, when I have faced a new problem in this field, I have gone back to embryology, anatomy and physiology in order to gain an idea of the meanings of those pathologic deviations which we are called on to treat. It may not be out of place at this time to outline sketchily some of the anatomic and physiologic principles that have grown up with the surgery of the abdomen, and on which depends the explanation of many phenomena that could not otherwise be understood.

From the time the food passes through the pharynx until it enters the rectum we have comparatively little control over it. Some control is exercised in the esophagus and even in the fundus of the stomach so that by initiating retrograde movements, retching, and so forth, some food may be ejected. The same is true in the sigmoid; but even in it the control at best is but partial and indirect. The biologists have pointed out that the theory of the three blastodermic membranes is a working rule and not a law, having many exceptions; but at least it leads to logical thought. To a certain extent this is also true of the idea of the derivation of the gastro-intestinal tract from the fore, middle and hind guts. Yet these primitive derivatives, while not as exact in the present day human body as might be desirable from a purely scientific point of view, have great value as outlines for the student.

From the foregut come the stomach, the duodenum down to the common duct, the liver and the pancreas, all organs which prepare food for digestion but do not themselves absorb. The stomach does not absorb even water, although it will take up certain chemicals and poisons, alcohol, for instance. The derivatives of the hindgut likewise absorb nothing except certain chemical substances, and rectal feeding, as spoken of in its ordinary sense, does not exist: it is simply a means whereby material placed in the rectum is quickly carried by what Bond calls "mucous currents" back into the derivatives of the midgut for absorption. The so-called colon tube passes out of sight through the anus, coiling in the rectum, and but seldom passes the rectosigmoid barrier. The derivatives of the foregut have their blood supply from the celiac axis. The derivatives of the midgut, in which absorption takes place, are supplied from the superior mesenteric artery, while the inferior mesenteric artery supplies the derivatives of the hindgut as far down as the rectum, and very largely the rectum also, although the rectum and anal canal obtain a small supply from the middle and external hemorrhoidals because of their origin from the cloaca and the proctodeum.

Rosenow's work on the specificity of bacteria shows that bacteria that have been cultivated in certain soils, in the gallbladder, for example, when placed in the circulation, are peculiarly attracted to the organ to which they have been acclimated. That is, strains of bacteria derived experimentally from a gallbladder will more often set up a cholecystitis than if they were derived from some other organ. This is true along so many lines connected with the vascular system that we must admit at least the possibility that the blood supply is to a certain extent specific and that organs exercise some peculiar chemotaxis which physiologically and pathologically directs certain substances of the blood content to them. How else can we explain the rapidity with which phenolsulphonephthalein is

eliminated through the kidneys? And recent work in physics suggests that the attraction may be a physico-chemical one. Very delicate instruments appear to show that each organ has its own electrical reactions and polarity, suggesting that cancerous growths can be recognized in this way.

Embryologically the first portion of the duodenum ends, not at the pylorus but at the common duct, and the duodenum above the common duct embryologically is a part of the stomach and a vestibule to the small intestine; like the stomach and other acid-containing organs, it is extremely liable to ulceration. Ulcers of the duodenum occur more commonly in men than in women, possibly because the first portion of the duodenum in women is more nearly horizontal, naturally permitting of a higher alkaline level for the bile and pancreatic juice, and thereby reducing the liability to ulceration. In animals with bilocular stomachs the division between the two stomachs is at the incisura of the human stomach, and the physiologic activity of the pyloric half of the stomach, especially at the incisura, is quite evident on roentgen-ray examination, although the musculature composing the primitive sphincter has disappeared.

The termination of the absorbing intestinal area in the transverse colon near the splenic flexure embryologically marks the end of the absorbing area. It is interesting to note that, although the proximal half of the large intestine has no marked anatomic differences from the left half, in the embryo villi are to be found in the right half which are similar to the villi of the small intestine, although they disappear as development proceeds. An observer, watching with the roentgen ray the churning back and forth in the head of the colon sees that the greater part of this activity is proximal to the location of the cecocolic sphincter which exists in the ascending colon of some of the lower animals, and that physiologic contractions are most marked in this situation. Retardation of the passage of food through the intestinal tract has its origin in embryologic physiology. Muscular control by means of sphincters, delay by means of the valvulae conniventes which also present larger exposed surfaces for absorption, delay by sacculations, as in the large intestine, and mechanical delays, such as the high attachments of the splenic flexure which necessitate muscular activity in order to pass the food refuse into the nonabsorbing part of the large intestine and render the descending colon physiologically empty, are examples. The rectosigmoid is a most remarkable mechanical device for retardation of food end-products. Since nature is most sparing of waste, even of water, in the terminal half of the large intestine, especially the sigmoid, the fluids are gradually squeezed out of the refuse and passed by reverse currents back into the proximal half of the colon for absorption.

Rotation has great surgical significance. In the embryo and in many lower animals throughout life the stomach hangs with its lesser curvature facing ventrally; and embryologically the lesser curvature is the anterior wall of the stomach. Rotation turns the stomach and pancreas on their right sides. The pancreas, embryologically an intraperitoneal organ, loses its posterior layer of peritoneum, which becomes fused behind with the fascia. This explains why, in the type of acute pancreatitis and fat necrosis which might be picturesquely called "perforation," the pancreas may involve the fat behind the peritoneum as well as the intra-abdominal fat; why occasionally, in traumatism,

pancreatic secretions escaping into the lesser cavity of the peritoneum may penetrate into the omentum and form a collection of fluid in what is known as the omental bursa, reopening the cavity which in fetal life exists between the layers of the omentum before they are fused as high as the transverse colon.

The position of the duodenum is altered by rotation and its third portion becomes retroperitoneal, a fact of great importance in connection with operations on the right kidney. Unless care is exercised in performing a nephrectomy in cases in which there is chronic inflammation around the pelvis, and especially in malignant disease, the duodenum may be injured, and immediately or a few days later a fistula form from which the patient may die unless it is repaired anteriorly by a transperitoneal operation. Very scanty mention of this accident is found in the literature, but I have reported several cases of this character. Unless careful dissection is made, this retroperitoneal portion of the duodenum also may be injured in the removal of cancers of the ascending colon.

Rotation as it affects the intestinal tract is also of great surgical importance. The large intestine, having its origin on the left side of the body, passes to the right and does not reach its normal situation until after birth. The late peritoneal attachments are often described as veils or adhesions, and are given unwarranted credit for causing trouble. Failure of rotation or partial rotation will cause the physical signs of an appendicitis to appear at whatever point the rotation of the head of the colon is interrupted. The attachments of the large intestine to the right side are not only late and less close than those on the left, but also, since the cubic capacity of the right lower thorax is less than that of the left lower thorax, because of the liver, the right kidney normally lies lower than the left. The nephrocolic ligament may be called on to bear much of the weight of the head of the imperfectly attached colon which acts like the car attached to a balloon, and may, by traction, drag the kidney down. We think of the large intestine as having a short mesentery; but as a matter of fact, it has a very long mesentery on the inner side, which is the only side of importance, as the blood vessels, lymphatics and nerve supply are always to be found in the inner long leaf which follows the colon during its migration. The outer peritoneal attachments which hold the colon in place laterally may, therefore, be divided without encountering any structures of importance, and the large intestine, on its long inner leaf of mesentery, can be drawn out of the body for easy manipulation and operation. There is one exception, that is, the attachments of the splenic flexure are derived from the omentum and contain a blood vessel which must be tied. Some years ago I called attention to this method of mobilizing the large intestine, which is based on these anatomic facts and very greatly aids in operations on the colon.

The small intestine, originating in six primary convolutions on the right side, has its mesenteric attachment from left to right, from above downward, passing behind the umbilicus. This is the reason why in obstructive and other disturbances of the small intestine, unless localized by involvement of the peritoneum, the pain is referred to the vicinity of the umbilicus, although the cause of the pain may be in a loop of intestine at a distance. In picking up a loop of small intestine, it is sometimes difficult to determine which direction is up and which is down. Monks, in a beauti-

ful piece of work, has shown how this can be done with facility. If a loop of intestine drawn out of an abdominal incision is held by an assistant, and the surgeon, grasping the intestine with the fingers on one side and with the thumb on the other, passes down to the bottom of the mesentery, and finds that his fingers and thumb still grasp the root of the mesentery as started above, the direction is up and down; but if the position is reversed at the base, then the direction is the opposite. In picking up a piece of small intestine one should be able to recognize the part of the bowel from its appearance. The upper jejunum is thick and wide, the mesentery is thin, and the vessels are large, long and straight, having but one or two primary arcades close to the base. In the lower ileum the intestine is thin and the mesentery thick, the fat sometimes following the vessels a little way up along the intestinal wall. The vessels are smaller, shorter, and there are a number of arcades, sometimes two, three or four, in the adjacent mesentery. Attention to these details makes ready differentiation possible.

The study of the peritoneum is profitable to the surgeon. The resistance of the peritoneum to infection is an inherited faculty. The meninges and pleura have less resistance. In the earthworm (common angleworm), the food, in its progress through the primitive gastro-intestinal canal, is admitted into the coelom, or body cavity, which is the forerunner of the peritoneum, for direct absorption. The contaminated peritoneum before infection takes place usually needs no drainage after mechanical cleansing; drainage often does harm rather than good. The slowly acquired special resistance of the pelvic peritoneum of women to infections in the course of countless generations of suffering from puerperal and other infections, is well known; and the mortality rate of operations involving the pelvic peritoneum, such as resections of the rectum for cancer, is much less in women than in men.

Let me repeat that the teaching of anatomy, as related to constructive surgery rather than to the destructive surgery of the past, should be based on the needs of the surgeon of today, to enable him to cope with the diseases of today. If I were to write a book (I have no intention of inflicting one on the medical public), I should take up the fascinating story of embryology, anatomy and physiology in relation to the work of the surgeon of tomorrow, the story of the anatomy of the living to enable us to treat the pathology of the living during the early stage of deviation from the normal physiologic state.

COORDINATION OF THE FUNCTIONS OF THE GASTRO-INTESTINAL TRACT

The two most primitive functions of a living body are maintenance of nutrition, and reproduction; and nature has thrown about these functions the greatest possible number of safeguards. First, the body must be nourished, and second, new life is to be brought into being. This is as true of the simple cell as of the most complex organism. The more ancient the organ, the greater its resistance. The small intestine has an enormous resistance to disease and seldom is the seat of neoplasm. The testicle, which is the primitive reproductive organ, has a long heredity and freedom from disease. On the contrary, the ovary, which is descended from the testicle is, like other less ancient organs, such as the stomach, the rectum and the large intestine, a frequent seat of neoplasm.

Methods of control over the visceral functions were established before man had a central nervous system; these controls are still independent of it. It might even be surmised that the attempt of the central nervous system to gain control over visceral and other functions previously established may have to do with neurasthenia, especially its visceral manifestations. Starling well says that those internal secretions which he calls hormones precede all types of nervous systems in visceral control. One is perhaps justified in looking on the sympathetic as the more primitive nervous system and in believing that the means whereby the central nervous system is attempting to gain this control over the vegetative functions is through the autonomic nervous system.

The liver, entirely separated from all its connections, can be made to secrete bile, and the kidney similarly to secrete urine. For that matter, the entire viscera have been completely separated experimentally from the nervous system and even lifted out of the body, and by appropriate mechanical connections made to live and function for some hours. The central nervous system, we find, has more or less control of those organs which have been added more recently, especially organs of convenience, such as the fundus of the stomach, into which a quantity of food may be placed rapidly for elaboration, as the magazine of a coal stove may be filled. The sigmoid and the bladder also have temporary storage function; but in other respects the central nervous system, beyond initiating action, plays a small part in vegetative life.

The growth of the central nervous system in relation to the organs of special sense is interesting. First, the sense of taste, which made the selection of food possible; second, the sense of smell, which enabled the primitive stoma to be turned toward food, and third, the sense of hearing, which was placed in the middle of the head because danger threatens from behind as well as in front. The sense of sight came during the rapid development of all the higher cerebral faculties, and direct pathways were established between the eye and all parts of the brain, so that the sense of sight overshadows in importance the other special senses. Even memory in most persons has its basis in visual phenomena. The relatively short heredity of the central nervous system accounts for its instability.

It is interesting to note that the sympathetic nervous system is in close relation with the endocrine glands, and that the importance of the internal secretion of an organ may be estimated by the closeness of its relation to the sympathetic system. The pituitary, one-half sympathetic and one-half gland, the suprarenal, with its similar association, and the thyroid, are examples; the spleen has no internal secretion of great importance, and only small connection with the sympathetic system.

Still another form of control is found in the primitive character of the nonstriated muscle. These fibers have the power of originating motion independent of a known nervous system. A little piece of the wall of the small intestine will contract for hours when placed in Locke's solution and properly stimulated. Many visceral functions are dependent on the nonstriated muscle. We are indebted to Keith for revelations with regard to the curious nodal system which acts to collect the impulses that have their origin in the primitive fibers of the nonstriated muscle. This has been most carefully studied with reference to the heart. The heart-beat starts in the sinu-auricular node, is

diffused through the auricular musculature, and is passed by the muscle-band of His to the ventricles, timing the ventricular beat. Keith's nodes are composed of a curious type of primitive muscle-cell with some fine fibers from the autonomic nervous system which evidently were added later. These nodes are in effect the controlling ganglions of the action of the nonstriated muscle in organs. Keith has pointed out the situation of eight nodes, four located and four not fully identified, through which control is maintained. When food passes through the pharynx, all direct control is at once lost, and here is situated the first node. The cardia is a true sphincter and normally is closed. The food passing through the esophagus arouses contractions in the nonstriated muscle of the esophagus; these impulses are carried to the second node, which relaxes the cardiac orifice. Failure to relax the cardiac orifice results in that curious condition called cardiospasm from which many persons suffer and starve for years, and often die from obstruction supposed to be due to cancer. If we have knowledge of the nature of the disease, cure is easy and certain. The third node is not at the pylorus as one would think, but at the termination of the primitive foregut near the common duct. It is interesting to note that, as pointed out by Ochsner, there are remnants of a prehistoric sphincter at this point. Disturbances of this node produce the condition called pylorospasm, which accounts for many gastric disturbances masquerading under different names. This node is also concerned in chronic gastric atony and some of the phases of acute dilatation of the stomach. The fourth node is near the duodenojejunal juncture and is concerned normally in peristalsis and in segmentation or pendulum movements of the small intestine, and abnormally in producing gastrosesenteric ileus. The fifth node is at the ileocecal juncture and is concerned with many of those phenomena about which Lane has written so interestingly under the general head of ileac stasis. The sixth node is near the middle of the transverse colon, and through its control of antiperistalsis prolongs the retention of food products for absorption in the right half of the colon. The seventh node is in the rectosigmoid region, and disturbances in the function of this node are probably responsible for the giant colon of Hirschsprung's disease. The last, or eighth, node is concerned with rectal control.

It may be said that wherever nonstriated muscle exists, the power of originating contraction exists. The intestine, like the heart, has two beats. The first, called the peristalsis, beats once or twice to the minute. The second, as pointed out by Mall, is the heart of the portal circulation and beats from eighteen to twenty times a minute, forcing the blood to the liver. In the pregnant uterus, the beat of the nonstriated muscle is recognized as the uterine contractions of pregnancy. Keith points out the part played by the nodes in controlling peristalsis, and suggests that they act like a block system on a railroad, and control food progress by controlling sphincters.

The endocrine glands secrete substances which Starling has called hormones; they act through the blood stream and form a most interesting chapter in visceral control; they are closely allied to the sympathetic nervous system, and are often found in glands of double function or glands that at one time have had an external as well as an internal secretion. The gonadal

secretion derived from the interstitial cells of the generative organs controls sex characteristic even when the genital elements are absent. The relation of the external pancreatic secretion dealing with the digestion of fats, starches and proteins has only an indirect connection with the tissue of Langerhans, which has to do with sugar metabolism. The thyroid in the king scorpion is a reproductive gland, and the thyroid function in the human being is closely connected with puberty, in the female, with the pregnant state. Types of life are found in which the thyroid functioned through the digestive tract, and the foramen cecum at the base of the tongue in man marks the site where this secretion was at one time discharged into the intestinal canal. In the present stage of human development, the thyroid is entirely an organ of internal secretion; but through its influence on other endocrine glands, it assists in maintaining reproductive and digestive functions.

The pituitary gland probably corresponds to the strainer gland in the fish stage, and in the course of development was left within the skull instead of on the side of the pharynx. It contains elements derived from the pharyngeal mucosa, and many of its tumors show pharyngeal heredity. Is it possible that this gland, which is so important in the growth of the body, is favorably affected through improved circulation by the removal of diseased adenoids and tonsils? Certainly one often sees a child of slow development, after an operation for removal of tonsils and adenoids, make a most striking physical and mental gain. The coccygeal body (gland of Luschka) has no known function, but it is connected with that stage of development in which the primitive hind or tail gut was part of the neurenteric canal. These prenatal vestiges may be the source of dermoids or neoplasms of peculiar nature, not infrequently malignant, lying in the hollow of the sacrum behind the rectum and eroding the bone. Some theorists have called the external vestigial remnants of the neurenteric canal the posterior umbilicus, and believe that the sequestration dermoids so frequently found in the lower sacral and coccygeal midline have this origin. Keith points out that the internal secretions of the five important endocrine glands, pituitary, suprarenals, gonadal, pineal and thyroid, control racial characteristics of the three great divisions of man, Caucasian, Negro and Mongol.

The sympathetic nervous system was a later development, and correlates visceral action. It stimulates the function of endocrine glands, and is in turn stimulated by their secretions. To the great English physiologist Gaskell we owe our knowledge of the involuntary nervous system. His first work on the visceral nervous system was published in the early eighties. Gaskell pointed out that certain small-calibered medullated nerves pass from the anterior horns of the spinal cord to the great sympathetic ganglion of the thorax and abdomen, which connects the central nervous system with the sympathetic. These connecting nerves enable emotions originating in the central nervous system to influence the sympathetic ganglion. From the sympathetic ganglion small nonmedullated fibers pass directly to their distribution forming the sympathetic nervous system. Gaskell also showed that there are nerves of the same kind which have visceral functions arising from the cranial nerves, and he called these parasympathetics. They are composed of the vagus nerve, the fibers in the third, seventh and ninth cranial nerves,

and the pelvic nerve from the sacral plexus. The parasympathetics are small-calibered medullated nerves with ganglion cells near their distribution, as in the heart itself and in the plexuses of Auerbach in the wall of the intestine. Neither the sympathetics nor the parasympathetics are under the control of the will, and when distributed to the same organ they follow Sherrington's law in that they are antagonistic.

Langley, who contributed much to this work, called the combined sympathetic nervous system (thoracic and lumbar ganglions) and the parasympathetic (cranial and pelvic) the autonomic system. American physiologists, especially Cannon and Crile, have contributed largely to this work. Gaskell pointed out that the sympathetic ganglions develop widespread reactions to stimuli which exercise inhibitory control over the vegetative system independent of the will, and inhibit the parasympathetics. The cerebrospinal nervous system produces conscious and accurate action of the striated muscle system, but has no control, and only indirect effect, on the nonstriated muscles. Langley, Crile, Cannon and Brown have made practical application of Gaskell's discoveries, showing how the fibers derived from the sympathetic ganglions, acting for defense, produce the most widespread and sudden effect when excited by emotions such as fear or anger. The digestive tract is temporarily deprived of function; the heart action and respiration increase in rapidity and strength, the glands of internal secretion, especially the suprarenals and thyroid, are activated, and sugar reserves in the liver and body generally are thrown into the blood stream to enable greater muscular action.

It is interesting to note that the nerves of Gaskell from the anterior horns of the spinal cord to the sympathetic ganglions are direct, and it is only those nerve fibers derived from the sympathetic ganglions themselves that pass to the various organs to produce the widespread effects spoken of, with the exception of the suprarenal gland, which receives fibers from the cord en route. The suprarenal contains within itself true nerve cells, as though at one time a start had been made for a different type of control from that which was afterward developed through the sympathetic ganglions. The parasympathetics of Gaskell, as related to the gastro-intestinal viscera, are composed of the vagus nerve derived from the bulbar division of the parasympathetics, and the pelvic nerve from the sacral plexus. When the emotions, which acting through the sympathetic system cause the sudden necessity for instantaneous use of all the body reserves, have passed away the vagus nerve comes into action and causes the heart to beat more slowly, and reduces respiration. The digestive tract, the stomach, intestine, liver and pancreas, which have been temporarily inhibited by the sympathetic fibers from the solar plexus, are stimulated to function through the vagus parasympathetic acting as a motor nerve through the plexus of Auerbach, and the pelvic parasympathetic motor nerve again permits conscious control of the bladder, sigmoid and rectum, which had been inhibited by the sympathetic fibers from the inferior mesenteric ganglion. One may well believe, however, that while these functions are checked by the sympathetic and are caused to resume action by the parasympathetics, control of their normal activities goes back to the nonstriated muscles, and the internal secretions which were the earliest forms of control. The gastro-intestinal tract is, therefore, largely con-

trolled in its functions by the nonstriated muscle and by chemical substances acting through the blood. The sympathetic ganglions act to inhibit these functions temporarily to produce rapid catabolism and spend reserves prodigally. The parasympathetics set in motion the interrupted anabolic activities and maintain reserves for future emergencies.

It may seem that these well known anatomic and physiologic details need no reiteration, and yet in my association and teaching of younger men in the profession I find that while they may know these facts, they often fail in their interpretation of them. The interpretation of the interesting phenomena which I have cited may not be correct in given instances; but if by "near-right" theories a dry subject may be made to live, the means will be justified and the strain on our memories will be less. We must not forget that memory training is the Confucian method which certainly has not led the Chinese in the paths of progress. Facts do not change. The interpretation of facts constantly changes, and new interpretations of old and new facts are the source of progress. Only as we are doubtful of our interpretations can we hope to advance scientifically.

EPIDEMIC (LETHARGIC) ENCEPHALITIS

CLINICAL REVIEW OF CASES IN THE PACIFIC NORTHWEST *

WILLIAM HOUSE, M.D.

PORTLAND, ORE.

"Westward the star of empire wends its way" setting an example that is followed with celerity by the humble but none the less busy germ. Most great epidemics have originated in the crowded centers of Europe or possibly of Asia and thence have traveled westward. On reaching the United States they have developed first on the Atlantic seaboard, within a few weeks or months have traveled to the Middle West, and within a year have invaded the Far West. The great epidemic of poliomyelitis¹ was reported in Sweden in 1905, visited the eastern part of the United States in 1907 and 1908, and came to the Pacific Northwest in 1909 and 1910, that is, between one and two years after it was reported in epidemic form in New York, Massachusetts and in general throughout the East. It had been preceded by cerebrospinal fever by two years. Later, less extensive epidemics of cerebrospinal fever traveled the same way. In 1916 and 1917 poliomyelitis was again epidemic in the Pacific Northwest following similar epidemics in the East, but the disease was much milder and cases were fewer than in 1909 and 1910. Influenza was several months in traveling from the crowded portions of the East to the West, and we had well written accounts of it as it was witnessed in the army camps of the East months before it visited the Northwest.

Epidemic encephalitis proves no exception to the rule. According to Bassoe² it first appeared in Austria in 1917, reached France and England in 1918, and in

the fall of the same year came to the United States. By the spring of 1919 cases were being reported throughout the Middle West. It reached the Pacific Northwest in October, 1919, appearing almost simultaneously in Portland, Seattle and Tacoma. Winslow³ of Seattle presented a paper which was written in the latter days of October at about the same time that I first saw cases of the disease in Portland. At a meeting of the Portland City and County Medical Society, Oct. 29, 1919, I reported four cases of this disease, two of which had already been fatal, and I have since (to December 10) examined nine more patients whom I regard as indisputably having this disease and at least four more in whom the diagnosis was open to some doubt. In each of these doubtful cases I saw the patient only once, and I do not know the later course or history.

EPIDEMIOLOGY

Except for the statements already made indicating that the disease occurs in mild epidemics, there is no hint of the method of spread. One of the most curious coincidences that I have ever witnessed occurred among my first five patients, three of whom dated their first symptoms definitely to October 12, and these three patients were separated by a distance of miles and knew nothing of one another. No two cases have occurred in the same household. None of my patients gave a history of preceding influenza, but several of them had low blood pressure and were in poor physical condition at the time of onset, suggesting that whatever the infection, the soil has to be prepared. I am convinced that the disease is not contagious in the ordinary sense of the word, and that there is no reason for quarantining patients other than keeping them isolated in their rooms away from the rest of the household, a precaution which can do no harm and may result in good.

TYPES OF THE DISEASE

Most writers say that the invasion of epidemic encephalitis is slow and deliberate. This is true in some of the cases, but by no means in all. I think I have been able to identify two types of invasion, one of which is rapid and the other slow.

Type One.—The slow type is far more common than the rapid, having occurred in ten of the thirteen cases. In this type the predominating symptoms from the beginning were double vision, slight mental confusion, at times mild delirium, followed by other symptoms which depended apparently on the particular cranial nuclei involved. After a week or ten days, the patients appeared to improve and then developed the so-called lethargy to which the disease owes its name. During this week most of them suffered from insomnia and were given some form of sedative by the attending physician. With the development of the lethargic stage, of course nothing of that kind was required.

Type Two.—This is more interesting in a way than the first type, largely because the manifestations are more dynamic. In this type, the patients complained of some head pain followed by a rapidly developing delirium, which was acute and attended by hallucinations of sight and hearing of the most vivid character.

One patient, a professor, conversed with imaginary friends and acquaintances and delivered lectures to his classes day and night for four or five days. During this time he was

* Read before the Oregon Association of Public Health Officers, Dec. 8, 1919.

¹ Owing to lack of space, this article is abbreviated by the omission of historical data and a discussion of the etiology of the disease. The complete article appears in the author's reprints.

1. House, William: Acute Anterior Poliomyelitis, *Northwest Med.* 2: 259 (Sept.) 1910.

2. Bassoe, Peter: Epidemic Encephalitis (Nona), *J. A. M. A.* 72: 971 (April 5) 1919.

3. Winslow, Kenelm: Epidemic Lethargic Encephalitis (Nona) in Seattle, *Northwest Med.* 18: 309 (Oct.) 1919.