

processes in clinical work as in so-called laboratory research. If that is possible, why don't we insist on it; why don't we apply it universally? There are not kinds of facts, so-called laboratory facts and clinical facts. If they are facts, they are facts, and they are established in the same way. I am familiar with Dr. Slye's work, and I have waited for this type of experiments on the hereditary cancer material. I should like to know whether these strains with the high incidence of spontaneous tumors are more susceptible to the various agents that induce so-called experimental tumors.

DR. FRANCIS CARTER WOOD, New York: The possibility of the locking up of cancer cells in the tissue for long periods is familiar to all students of the disease. It may occur after radiation treatment, or after radical removal of a tumor. One interesting example was a patient with epithelioma of the lip who had been treated thirteen years previously with radium. A recurrence took place at exactly the same site as the primary tumor and with exactly the same morphology. The assumption that a new tumor had occurred at the same place is therefore unwarrantable. In other words, for thirteen years cancer cells remained in abeyance in the scar. There are many other examples of late recurrence in scars produced by treating cancer with caustic paste or after freezing squamous cell epitheliomas of the face with carbon dioxide snow; also I have seen many scar recurrences after radical mastectomy five and ten years after the operation. The facts of which Dr. Carlson spoke are well illustrated by certain experiments on rats at the Crocker Laboratory. By infesting the animals with a parasite which forms a cyst in the liver, we have been able to find those whose livers were susceptible to irritation by the production of a sarcoma. This in the ordinary run of laboratory rats is about one in 500. By breeding together those rats which proved to be susceptible to the development of a tumor, we have obtained a susceptible strain whose livers have an enormous susceptibility to the irritation of a parasite. Sometimes we get a 100 per cent. susceptibility in a litter of animals. This shows that by selective breeding the liability of an organ to develop cancer under the action of a definite stimulus can be concentrated. In other words, it demonstrates in rats what has been known for forty years in man, that a congenital tissue susceptibility is transmissible. The answer to Dr. Carlson's question brings out a theory tested by another experiment: The skin of the ordinary white rat does not react to tar painting by the production of cancer, though the skin of mice is exceedingly sensitive. We thought that possibly the strain of rats with highly susceptible livers might also have skins which had become susceptible, but on painting a large number of animals with tar no skin susceptibility was found. Thus the susceptibility was entirely for a single tissue—the connective-tissue structures of the liver.

Gland Extracts Mostly Devoid of Action.—We meet with advertisements of extracts of blood (hemoglobin), bone marrow, muscle, spinal cord, brain, lymph gland, spleen, prostate, ovary, testis, mammary gland, duodenum, pancreas, liver (bile), placenta, gastric mucous membrane and kidney, to say nothing of the adrenal bodies (both cortex and medulla, and the whole gland); thyroids, parathyroids, pituitary body (both anterior and posterior lobes and the whole organ), the pineal body, and the corpus luteum. Various mixtures of these extracts are also put on the market and are presumably sold, as e. g., ovary and mammary gland extracts, mixtures of extracts of lymph gland, testis, spinal cord, and brain; combinations of thyroid and pituitary substances, and of thyroid adrenal extracts; such combinations as "polyglandin," a mixture of thyroid, parathyroid, ovary, testis and pituitary extracts. Several of these combinations are sold with or without the addition of the drugs, under various fanciful names, as "virtilogen," "mammagen," "ferovarim," etc. Now in the case of the great majority (in fact, in all except one) of these preparations there is no evidence that any effects whatever are produced when they are given in the ordinary way by the mouth, unless they are given in such quantities as to serve as foods.—*Vincent, Swale: Proc. Royal Soc. Med.* **18:30** (June) 1925.

REVERSE PERISTALYSIS IN THE BOWEL, A PRECURSOR OF VOMITING *

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It is remarkable how little has been written about the behavior of the bowel during the act of vomiting. One can read for days about the rôles played by the medulla, the vagi, the pharyngeal sensitive points, the esophagus,

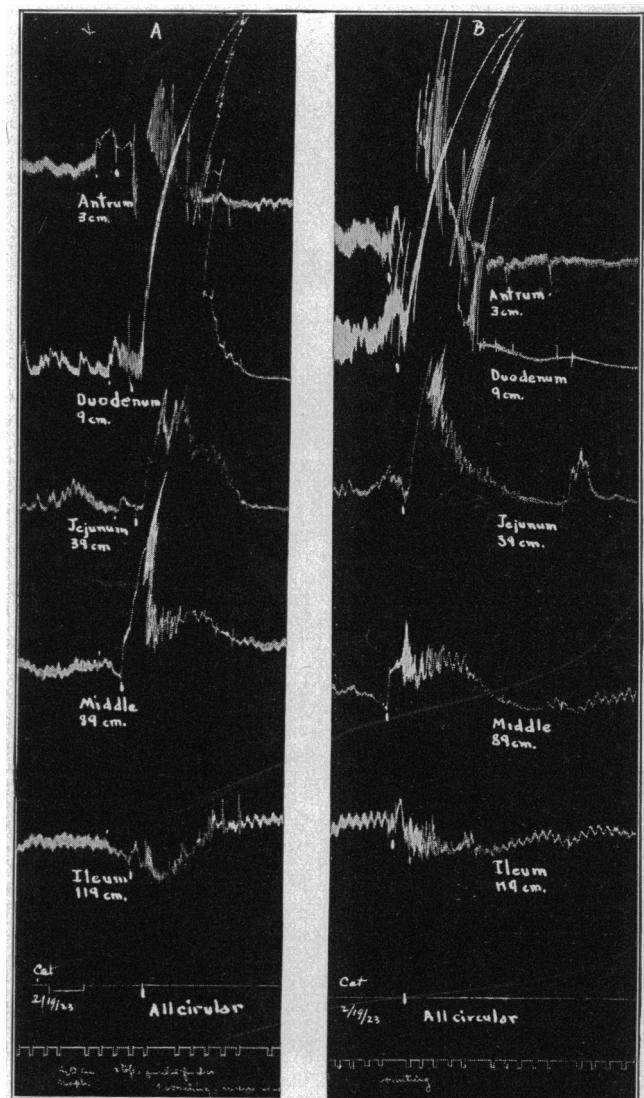


Fig. 1.—Records depicting waves of reverse persitalsis in the cat's bowel preceding vomiting.

the abdominal muscles and the stomach, but only here and there will one find a brief reference to the bowel. Significant of this state of affairs is the fact that in Hatcher's¹ summary of our knowledge about vomiting I can find no word about the bowel.

Certainly there must be some reason for this blind spot in our vision, and the most probable one is that we have never been able to record exactly what is going on in the various parts of the bowel at the same time. Another reason is that in our lay youth we become so

* From the George Williams Hooper Foundation for Medical Research, University of California Medical School.
1. Hatcher, R. A.: *Physiol. Rev.* **4:** 479 (July) 1924.

used to thinking of the stomach as the organ of digestion that later, when we should know better, we sometimes forget that there is such a thing as a bowel. Another trouble lately is that our attention has been diverted from the abdomen to the vomiting center of the brain, largely on account of the experiments of Eggleston and Hatcher² which showed that an animal can retch even when its digestive tract from cardia to anus has been removed.

Although there can be no question about the importance of the nervous mechanism which Hatcher and his

empty itself orad without any help from the abdominal press; and we see much the same thing in infants and some adults when large amounts of material are regurgitated from the stomach without apparent effort. Actually, in these cases it is often hard to say whether we are dealing with pure regurgitation or real vomiting, because they shade so, one into the other.

Clinicians and surgeons know also that men and women with acute appendicitis or other irritating or obstructive lesions in the bowel will sometimes vomit large amounts of fluid a few minutes after their stomachs have been washed clean. This fluid will often be bile-stained or tainted with feces or enema material, showing clearly that it has come from the bowel.

The strange inability of many writers to conceive of an active reversal of peristalsis in the bowel is shown again by their rather thoughtless statements to the effect that this regurgitation is due to suction by the stomach. Just how this suction is accomplished by soft collapsible tubes that cannot actively dilate is not specified.

Twelve years ago, when I first began the study of the intestine with the animal opened under salt solution, I saw on several occasions waves of reverse peristalsis. I was watching the intestines of cats under urethane anesthesia, with their lower cords pithed, the rectum tied, and the colon filled with pea-soup or soapy water. After an hour or more the colon would usually become very active in its efforts to rid itself of its contents, and occasionally then a wave carrying some of the soapy water would travel rapidly up to the jejunum or even to the stomach.

On many occasions also I was struck by the fact that gastric regurgitation or actual vomiting had been preceded by a short period during which there was great activity in the small bowel. On searching through the literature, I found that some of the older writers on vomiting had observed this phenomenon. I observed it also in a man with a jejunal fistula. He happened to vomit one day while I had a balloon in his bowel, and it was very evident from the record that a marked increase in the activity and tone of the jejunum had, for about two minutes, preceded the retching. Actual reverse transport of material was shown by the fact that he vomited the egg-milk mixture that had been given him through the fistula.

Two years ago when Miss Mahoney and I³ began to get good records from several parts of the cat's bowel at one time, we were able, not only to see a number of reverse rushes traveling up the bowel, but also to record them graphically. Two typical records are shown in Figure 1. Unfortunately, details of the gastric record were obscured by the retching movements. In Figure 1A it will be noted that vomiting was apparently initiated by a pinching of the fundus of the stomach. The effect of this pinch was registered immediately from one end of the tract to the other, and fourteen seconds later a small reverse rush passed the recorder on the ileum 119 cm. from the pylorus. It seemed steadily to gather force as it went, and it passed the upper duodenum, 9 cm. from the pylorus, six or seven seconds later. Its rate of travel was therefore from 16 to 18 cm. per second.

Figure 2 shows what happened when the animal regurgitated so much that, for a moment, we thought that it was really vomiting. The record shows, however, that there were no retching movements. A rise

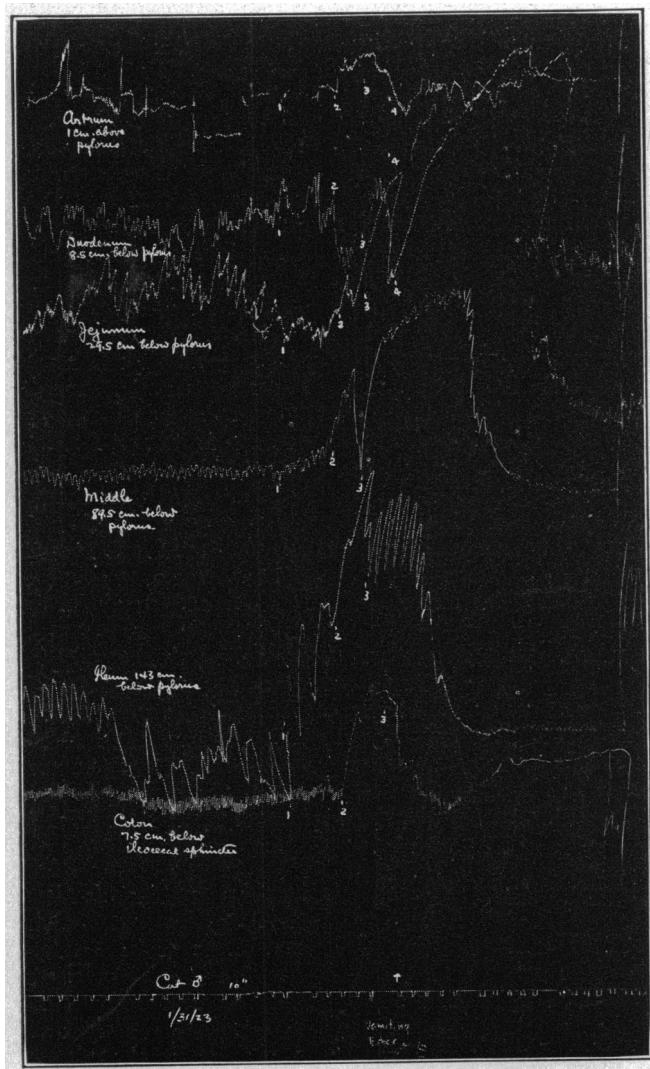


Fig. 2.—Record depicting a combination of tonus contractions and a reverse wave associated with vomiting.

associates have demonstrated, it seems to me that the possibility still remains that certain types of vomiting either originate in reverse peristalsis in the bowel or else are associated with it. I see no reason why the emptying of the intestinal contents into the stomach or even the mere reversal of peristalsis in the bowel should not be one of the many factors that we know can call forth those coordinated activities of stomach, diaphragm, abdominal muscles and esophagus which we call vomiting.

We know also from the experiments of several workers on different animals that the stomach can

2. Eggleston, Cary, and Hatcher, R. A.: J. Pharmacol. & Exper. Therap. 8: 551, 1912; 7: 225, 1915.

3. Alvarez, W. C., and Mahoney, L. J.: Am. J. Physiol. 69: 212 (July) 1924.

in tone began practically simultaneously in "middle" and "ileum." A wave then traveled steadily from the ileum to the duodenum but did not seem to reach the stomach. At 2, there was another rise in tone, which was almost synchronous from colon to stomach. The only exception was that the duodenum responded with a drop. At 4, the animal regurgitated, and the tone of the gastric antrum fell. The interesting feature here is the reverse wave traveling up the bowel, associated with peculiar rises in tone which appear at the same time in almost all parts of the tract. I have commented before on a similar phenomenon in the stomach where systoles are sometimes associated with waves traveling up and down. Attention is called also to the marked drop in tone that occurred in the ileum two minutes before the rise began, and 4.5 minutes before the animal regurgitated.

Figure 3 shows again how long a time the intestine may spend in preparing for a vomiting spell. We note the rise in tone of the duodenum and jejunum at *A*, three minutes before the animal began to retch. A second disturbance, which appeared throughout the tract at 1, was most marked at the lower end. It traveled upward so slowly that it reached the stomach after vomiting had begun.

Dr. Zimmermann and I have recently obtained records from a rabbit showing an orad progression of powerful contractions. Unfortunately, we could not see clearly what was going on, so we cannot say definitely that it was a reverse rush wave, but that is the logical inference from the records.

COMMENT

The fact that a number of these records show a temporary depression before the sudden rise which marks the advancing wave, brings up the question of Bayliss and Starling's law. Such a depression is assumed by most writers to mean temporary inhibition; but when we watch very carefully we see that some, or perhaps all of it, can be due to distention by the column of intestinal contents, which is pushed ahead by the contraction-wave much as a train of cars is pushed by an engine. We cannot deny that there may be an element of inhibition sometimes present, but neither can we assert that it is present until we can exclude this element of distention.

If we should decide that at least a part of this drop in the record is due to inhibition, we would be faced by a difficulty in that we could no longer follow those who say that the myenteric reflex is brought about by a certain arrangement of neurones in Auerbach's plexus. Such a structure could hardly be reversed so suddenly. Furthermore, if the myenteric reflex will work equally well both ways, up and down the bowel, we can no longer ascribe to it the faculty of maintaining the caudad direction of peristalsis.

We have some difficulties also in reconciling our findings with the gradient theory. According to that theory, waves travel down the bowel simply because there is a gradation in metabolic rate, tone, rhythmicity and sensitiveness to distention or to the presence of food, from the duodenum to the ileum. Material moves from the more active, irritable regions to less active and less irritable ones. Although this gradient is built into the structure of the bowel, it can probably be upset quite easily by agencies which either increase the activity of the lower end or lower that of the upper end. Sometimes we can show a flattening or reversal of the

rhythmic gradient in sick animals or in animals that have been vomiting or refusing food, but there are puzzling exceptions. We find also that distempered dogs will have a decided flattening or reversal of the gradient of latent period without much change in the rhythmic gradient.

Flattened rhythmic gradients were actually found in a number of the regurgitating cats observed during this study, but it happens that the particular animals whose records are shown here had a good gradation running

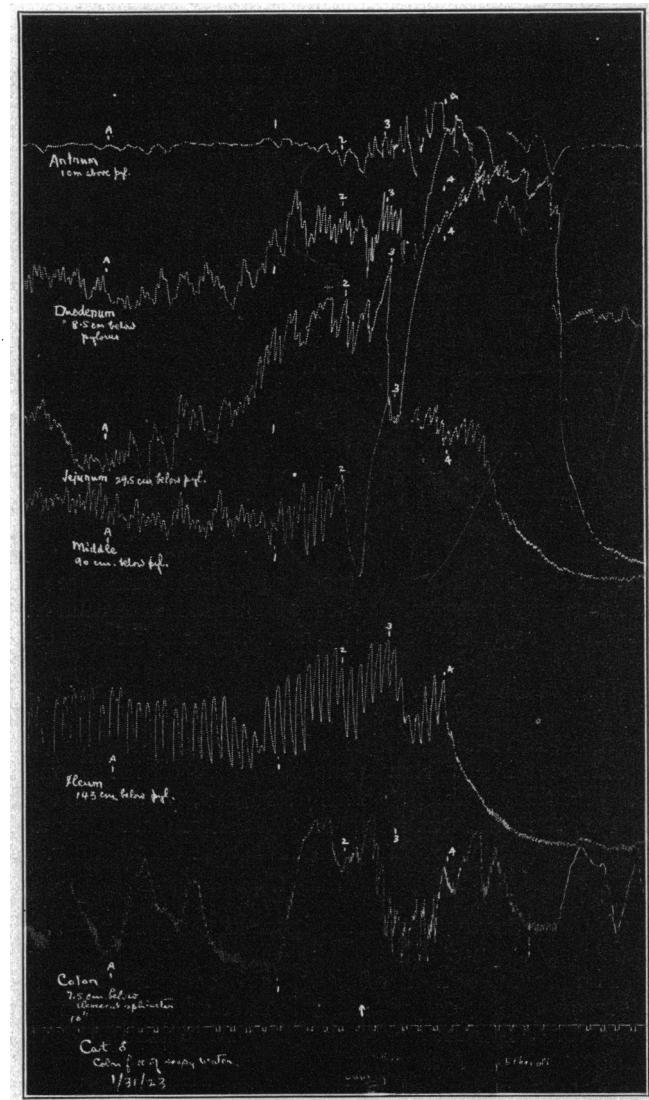


Fig. 3.—Record showing how long the bowel may take in preparing for vomiting. In this case the reverse wave reached the stomach after vomiting had started.

from 18 per minute in the duodenum to 10 in the ileum. The rabbit with signs of reverse peristalsis had no rhythmic gradient below the upper jejunum. This was due to a lowering of the normal rate in the duodenum and jejunum and a rise in the rate of the lower ileum. Just why this occurred we do not know, as the animal seemed to be healthy.

Studies on scores of animals during the last twelve years have given me the impression that the rhythmic gradient is not changed much by acute processes such as sudden intestinal obstructions. It seems to be flattened or reversed only if the animal is sick for some time. Reverse peristalsis may take place in animals

with good gradients if the tone or irritability of the lower end of the tract is raised sufficiently. Once the wave is started orad it can travel even against the gradient, because the material that is pushed ahead is constantly giving rise to new contractions. Regurgitation caudad cannot take place because, as we may see from the records, the bowel remains tonically contracted for a minute or two after the wave has passed. By that time, the head of the onrushing column is far away. This mechanism has been discussed more fully in another article on peristaltic rush.³

Naturally, when there are powerful contractions and marked rises in tone in the lower ileum, waves may travel out in both directions from the irritable point, and we know that diarrhea actually is often associated with vomiting.

It is well known, of course, that regurgitation from the duodenum into the stomach is a normal happening at certain stages of digestion.

There would seem to be no question, then, that vomiting is often preceded by an increase in the activity of the bowel, by a rise in tone there, and sometimes by a wave of reverse peristalsis. Unfortunately, we cannot yet say just what bearing these changes have on the events that follow. They may lead up to the vomiting act and may be partly or largely responsible for it, or they may be but a part of the vomiting complex brought on by influences coming from the center in the medulla.

As I⁴ pointed out several years ago, it is suggestive that nausea is felt by many people in ascending waves which may perhaps correspond to actual waves on the bowel. Many persons are distressed the minute their hearts develop abnormal types of rhythm, and I see no reason why abnormal types of peristalsis should not similarly register themselves in some way on our consciousness.

Just as this paper was being sent off, the article of Keeton⁵ appeared in which he reports the production of nausea in human subjects by the injection of various substances into the duodenum. Some of his findings suggest that, with the waves of nausea, the bulb on the end of the tube was returned to the stomach. Ivy and Vloedman⁶ have recently observed the same thing.

SUMMARY

Writers on vomiting have ignored the part played in the act by the bowel.

The regurgitation of intestinal contents into the stomach during or preceding the act of vomiting must be a common occurrence, judging from clinical observation.

Records made simultaneously from several regions of the bowels of cats, opened under a warm bath of salt solution, show that vomiting or regurgitation of gastric contents is almost always preceded by an increase in the tone and activity of the small intestine. Actual waves of reverse peristalsis have also been observed and recorded.

An increase in the tone and activity of the jejunum beginning two and one half minutes before the onset of vomiting was recorded graphically in a man with a jejunal fistula. Food put into the fistula was vomited.

Depressions which suggest a preliminary inhibition, but which may be due only to distention by the oncom-

ing intestinal contents, are observed in some of the records. If we assume that this represents inhibition, then Bayliss and Starling's law can be demonstrated with reverse waves as well as with caudad ones, and it can no longer be assumed to be the cause of normal peristalsis.

THE DOG AS A CARRIER OF DISEASE TO MAN *

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AND

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Our object in this paper is to emphasize the fact that the dog acts as a carrier of disease when not properly managed. No attempt will be made to give a detailed discussion of the various diseases that a dog may carry. Our purpose will be accomplished if groups interested in public health and hygiene will consider the dog as a possible carrier and study him from that point of view.

The fact that the dog is a carrier of disease has been recognized by parasitologists and zoologists all over the world. With the exception of the work of M. C. Hall¹ in this country and Cameron² in England, no recent concentrated effort has been made to bring this problem before the general public or even before the medical profession. In Minnesota, some attempts have been made to bring the topic before the medical profession.³

There are two modes of disease transmission by the dog; first, when the dog contracts a disease and carries it to human beings, or when it acts as an intermediate host of various parasites; second, by coming in contact with some infected article and carrying the infection into the household. As a pet, the dog has become a very intimate member of the home. The average pet dog is allowed to lie on its master's bed, or even to eat from the same plate. The dog is allowed to roam, and on coming back is permitted to play with the children of the family, and thus renders possible infection with various animal parasites, skin diseases, or pathogenic bacteria.

During the last two years, we have examined the intestinal lumen of all our laboratory dogs that came to necropsy. Our observations convinced us that it would be unusual if a dog did not have intestinal parasites. Although most of the parasites have adapted themselves to the conditions found in the dog's intestine, and perhaps may not be obnoxious in the human intestine, still there are parasites, such as various trematodes, nematodes and cestodes, that are definitely pathogenic for man. The dog may carry skin parasites, such as scabies, fleas, lice or ticks. Of the diseases of man caused by the grosser animal parasites, echinococcus is the most serious. Although more than 350 cases have been reported for this country,⁴ the actual number of infections is undoubtedly much greater. Practically the only primary host of the echinococcus is the dog.

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¹ Read before the Section on Preventive and Industrial Medicine and Public Health at the Seventy-Sixth Annual Session of the American Medical Association, Atlantic City, N. J., May, 1925.

² Hall, M. C.: The Dog as a Carrier of Parasites and Diseases, Bull. 260, U. S. Dept. Agric., Nov. 23, 1915.

³ Cameron, T.: The Dog as a Carrier of Disease to Man, Lancet 1: 564 (March 18) 1922.

⁴ Joannides, Minas: The Relation of the Dog to Public Health, Minnesota Med. 8: 302 (May) 1925.

⁵ Joannides, Minas; and Riley, W. A.: Echinococcus Cyst in the Scapular Area, Report of a Case, Arch. Surg. 9: 537 (Nov.) 1924.

4. Alvarez, W. C.: The Syndrome of Mild Reverse Peristalsis, J. A. M. A. 69: 2018 (Dec. 15) 1917.

5. Keeton, R. W.: Nausea and Related Sensations Elicited by Duodenal Stimulation, Arch. Int. Med. 35: 687 (July) 1925.

6. Ivy, A. C., and Vloedman, D. A.: Am. J. Physiol. 72: 105 (March) 1925.