ON THE
INVESTIGATION OF GASTRIC FUNCTION
BY MEANS OF THE FRACTIONAL
TEST-MEAL.¹

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IN 1914 Rehfuß described a method of obtaining a continued record of the digestive functions of the stomach with the aid of a small-bore rubber tube, having attached to its lower extremity a perforated metal bulb, through which samples of a test-meal were withdrawn at intervals until the stomach was found to be empty. Analyses of the free hydrochloric and total acidity were made on the samples withdrawn and the results were plotted as a curve. The method has many obvious advantages over the old one-hour test-meal.

Together with his co-workers—Hawk, Fowler, Bergeim, and Clarke—Rehfuß published several accounts of the findings obtained both in healthy subjects and in sufferers from various gastric disturbances. Crohn and Reiss have also published observations mainly on hospital patients and having particular reference to the action of acid, antacid, and other drugs on the secretory cycle.

For some reason, however, the fractional method of gastric analysis does not appear to have been widely adopted in this country.

At the beginning of the present year the writer started to review the method both as a means of studying normal gastric physiology and as an aid to clinical diagnosis. Investigations on an extended scale are now in progress, but the results up to date have been so instructive that it seemed desirable to publish a brief account of the method and to forecast some of its possible applications, if only with a view to obtaining for it a wider recognition and trial. With the aid of a Rehfuß's or Einhorn's tube it has become possible to repeat on the healthy human subject a number of the historical animal experiments of Pavlov, and under circumstances far less troublesome and abnormal, while in clinical inquiries the information obtained may be so abundant that, in comparison, the worth of the one-hour test would appear to be greatly diminished. The writer has been able to confirm many of the findings of Rehfuß and to add a few additional observations to those already on record.

The present report consists of: (1) An abridged account of the technique. (2) Reproductions of specimen charts illustrating (a) physiological, (b) pathological phenomena. (3) A summary of the advantages of the fractional method of gastric analysis.

Technique.

The tube employed has been a rubber one, equal to a No. 6 or 8 soft catheter. Attached to the lower end is a small oval brass bulb containing numerous perforations. This is swallowed by the patient and the tube is rapidly "paid out." With explanation and kindly encouragement there should be no failures. Both in the descent of the tube and during withdrawal there is a tendency for the bulb to stick at the constriction corresponding with the cricoid. In withdrawal no force should be employed, but the patient should exert slight tension on the tube and swallow. As the wave of relaxation passes over it the bulb slips into the mouth. With the tube in place a specimen of resting juice is withdrawn and the total amount if necessary measured. A Record or all-glass syringe should be used for preference for withdrawing samples. A rack of 10 or 12 numbered test-tubes is at hand. The patient without withdrawing the tube drinks one pint of test-gruel prepared according to a fixed recipe,² and at intervals of quarter of an hour specimens

of about 10 c.cm. in bulk are aspirated. After sedimentation in the tubes has occurred naked-eye observations are made of the food-content and the presence and amount of mucus and bile; the free and total acidity are determined quantitatively by the usual tests; and the time of disappearance of starch is noted by adding iodine to the residue in the tubes. An average curve in a healthy subject presents the following features. From a resting free acidity varying

CHART 1.

between 0 and 20 (N/10 NaOH), and following an initial fall due to dilution, there is a gradual rise up to 1 1/2 or 2 hours, the maximum seldom exceeding 40 for the free or 60 for the total acidity. The curves run closely parallel. There is a slight drop from 2 1/4 to 2 1/2 hours, at which time emptying is usually complete. The starch disappears in the last or penultimate specimen. There is a tendency for the mucus to increase as the food diminishes. Bile regurgitation may be present in the resting juice, and occurs at some period of the cycle—usually towards the end—in about 50 per cent. of

CHART 2.

healthy males. The criteria of approaching emptying are the withdrawal of frothy specimens of small bulk, the appearance of bile, and the disappearance of starch.

The figures for the acid are lower than those obtained with Ewald's test-meal, probably on account of the elimination of the psychic factor, the oatmeal gruel being somewhat unappetising and demanding no mastication.

Specimen Charts.

Chart 1 was obtained in the writer's case. It may be regarded as an average normal curve; it conforms with the type of curve obtained in upwards of 75 per cent. of healthy males.

Chart 2 shows the result of a milk test-meal of one pint obtained in the writer's case. Note the high-rising total acidity indicating the specific food response; the inverse ratio of free and total acidity after 2 hours possibly indicating acid-protein combination; and the slow rate of emptying—4 hours—probably due to the presence of fat, since skimmed milk in equal bulk emptied in 2 1/4 hours, while a meal of

¹ Based upon a communication made to the meeting of the Association of Physicians at Manchester.
² Mix two tablespoonfuls of breakfast oatmeal with one quart of water. Boil slowly down to one pint. Strain through muslin. Add salt to taste and give warm.

cream and water of similar bulk took $4\frac{1}{2}$ hours to empty, and after the initial rise, probably caused by the water, showed a very low output of HCl.

Chart 3 shows the result of drinking half a pint of water. Emptying was not complete for 55 minutes, but took place rapidly after the free acid reached 30. Emptying appeared to become active at this degree of acidity in all the writer's tests, the attainment of this point, at whatever phase of the curve it occurs, coinciding with the most active

CHART 3.

Water test-meal (half-pint) normal.

CHART 4.

Duodenal ulcer (without "hurry").

CHART 5.

Duodenal ulcer (with "hurry").

subjective peristaltic sensations and sometimes with audible borborygmi.

In experiments extending over a period of a month no effect on resting or active juice as the result of deficient or excessive salt intake could be demonstrated. The resting juice was found to vary in its free acidity from 0 to 20 and showed wide variations in the actual amount obtainable.

CHART 6.

Pyloric neoplasm.

CHART 7.

Acne rosacea showing achlorhydria.

In the pathological series:—

Chart 4 is from a case with history and symptoms strongly suggestive of duodenal ulcer. Note the high acidity of the resting juice, which is very copious, the steep-climbing curve, and the continued secretion. Curves of this character have been very constantly obtained in "duodenal" cases.

Chart 5 is from a case of duodenal ulcer confirmed at operation. In this case a clinical and X-ray diagnosis of chronic gall-bladder and appendix was made. The additional diagnosis of ulcer was made on the test-meal result. Note that at one hour the acidity is within normal limits, whereas half an hour later there is definite hyperchlorhydria. Note also the extremely rapid emptying—"duodenal hurry"—the presence of blood in 8 out of 10 specimens, and the continued secretion.

Chart 6 is from a man, aged 51, whose clinical features strongly suggested growth; vomiting was absent, but the test showed very definite pyloric delay. In addition there is achlorhydria and a big disparity between free and total acidity.

Chart 7 is from a case of acne rosacea. In this condition, the association of which with indigestion is well recognised, achlorhydria or marked hypochlorhydria has been very constantly demonstrated.

Summary.

The advantages of the fractional method of gastric analysis may be summarised as follows:—

(1) Its technique is extremely simple. Both for patient and operator the manipulations involved are easier and less unpleasant than is the case with the large stomach-tube.

(2) It is probably the best method yet described for investigating and also for demonstrating to students the secretory functions both of the healthy and the unhealthy human stomach. For—

(3) It allows of a graphic presentation of the whole digestive cycle with reference to the free and total acidity, the secretion of pepsin, the secretion of mucus, the regurgitation of bile, and the rate of disappearance of starch and sugar from the examined contents.

(4) It allows of an estimate of the rate of emptying at least as accurate as that obtained by means of radiography and the barium meal.

(5) It allows of qualitative and quantitative investigations of the resting juice and of the post-prandial secretion (when present), and of its cytology and bacteriology, as well as its chemical features.

(6) It avoids the fallacy of a one-hour reading with subsequent or previous abnormal variations.

(7) It makes possible the investigation of certain symptoms, such as "heartburn" and of pain, having special time relationships.

(8) It permits of the study of the local action of drugs taken into the stomach and of reflex secretory effects.

(9) By means of parallel X ray examinations a correlation of chemical and mechanical functions becomes possible.

(10) Owing to the whitish colour of the gruel employed

and the number of specimens withdrawn small quantities of macroscopic blood are much less likely to escape detection than with the older methods.

If necessary investigations can be pursued beyond the pylorus, as, with X ray coöperation, the bulb can easily be passed into the duodenum.

No attempt has been made in this communication to

base conclusions on the results thus far obtained, for the inquiry, so far as the writer and his colleagues are concerned, is still in its early stages.

Thanks are due to Dr. A. F. Hurst, who has largely stimulated the investigation and provided numerous cases of interest; to Dr. M. S. Pembrey and Dr. J. H. Ryffel, in whose laboratories at Guy's Hospital the work has been done; to Dr. T. I. Bennett, who is at work on normals and also upon pharmacological effects; and to Mr. M. Maizels and numerous students who have volunteered to act as subjects in order to

help in the establishment of the normal variations.

For the illustrations (Figs. A and B) of the tubes employed the writer is indebted to Messrs. Down Brothers. Fig. B is a modification designed to facilitate swallowing and to avoid the possibility of slight trauma to the gastric mucosa when strong suction is exerted through the metal bulb on an almost empty stomach.

References.—Rehfuß and Hawk: *Journal of American Med. Assn.*, vol. lxiii., No. 1, p. 11. Rehfuß, Bergeim and Hawk: *Ibid.*, No. 11, p. 909. Rehfuß and Hawk: *Ibid.*, No. 24, p. 2088. Fowler, Rehfuß and Hawk: *Ibid.*, vol. lxv., No. 12, p. 1021. Rehfuß: *Ibid.*, vol. lxiv., No. 7, p. 569. Rehfuß, Fowler and Clarke: *Ibid.*, vol. lxiv., No. 21, p. 1737. Rehfuß: *American Journal of Medical Sciences*, 1914, p. 848. Crohn and Reiss: *Ibid.*, 1917, p. 857; 1918, p. 801; and 1918, p. 656.

Tubes used in fractional gastric analysis (described in text).

ANTISYPHILITIC PROPHYLAXIS:

AN INVESTIGATION INTO ITS USE, NON-USE, AND MIS-USE.

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IN order to arrive at some figures with regard to the use of venereal disease prophylaxis by men and at some true information as to what, if any, precautions are being taken amongst the class of people who present themselves at one of the ordinary public centres for the free treatment for venereal disease, I have recently collected information from 608 cases who presented themselves at the syphilis clinic at the London Hospital under my chief, Dr. J. H. Sequeira.

Scope of Inquiry.

This report has reference solely to syphilitic infection and to no other venereal disease.

For the most part the men concerned were of the ordinary hospital out-patient class, but there were some more intelligent people amongst them, such as military officers or clerks. The plan adopted was the private questioning of each individual patient, and I have every reason to believe they answered questions truthfully. As far as possible the cases were taken consecutively as they came on certain special days for syphilis. Careful

attention was directed towards accuracy of time of events; what precautions were used, and how used, and whether before, after, or during connexion; how much of the prophylactic agent was used, and whether the patient had had any intoxicating liquor at the time or not.

Many interesting and useful points were elucidated during the questioning.

Many contracted the disease while in France from "licensed houses," and because the houses were "licensed" they all, without exception, believed the women were "clean," and therefore took no precautions at all. This fully endorses what Lieutenant-Colonel E. T. Burke, R.A.M.C., says in his article¹ on "Venereal Disease in War":—

"The licensing of brothels and the medical examination of the inmates possess not the slightest value. This has been fully proved wherever it has been tried. In spite of medical examination it is quite impossible to guarantee that any public woman is free from infection. Regulation gives a false sense of security and makes the authorities directly responsible for any infection that may result."

Some believed that a solution of potassium permanganate, or Condy's, applied by a few moments' douching, and of no matter what strength and how long after the connexion, was sufficient protection. Others believed that the washing of their parts with their own urine, even hours after, was also sufficient protection against venereal disease. Ordinary washing with soap and water soon after connexion was very rarely done. Lysol and other similar drugs were used by a few, even to a strength which resulted in burns. Of those infected after using a rubber sheath, each definitely states that the sheath broke during connexion. (See below.) The high percentage of those infected during partial or total intoxication by liquor will be referred to later.