Some surgeons advocate excision of the ulcer as well. When the ulcer's margins are not markedly indurated, and when inversion can be readily effected, it is not worth while to excise. In perforation excision is rarely necessary. In some ulcers which have not perforated and in a few which have, excision is advisable. In a recent case in the Philadelphia Hospital, I was obliged to excise an ulcer which had not perforated. Excision was required because the surrounding induration made marginal inversion impossible. The abdominal cavity is then carefully cleansed, the stomach is washed out, a piece of gauze for drainage is carried down to the stitch line, and the abdominal wound is closed.

In ordinary, non-perforating ulcers, medical and dietetic treatment is indicated in the majority of cases; but if, in spite of such treatment, a patient grows progressively worse, if the pain is violent, or if tenderness is marked, the abdomen should be opened and the stomach should be inspected. A single acute hemorrhage, even if large, does not call for operation; but if the hemorrhage is repeated, operation should be performed. A number of small hemorrhages call for operation. Cabot lays down the sound rule that if an ulcer tends to recur or if it lessens the ability of the patient to work—especially if he must work to live and cannot regulate his diet—an operation should be undertaken.

In operating for chronic ulcer, it is wiser, in most instances, to excise the diseased area, suturing the gap (see Partial Gastrectomy and Gastrorrhaphy). If we are operating for hemorrhage from an ulcer in the anterior wall, the hemorrhage is best controlled by excising the ulcer. In hemorrhage from an ulcer in the posterior wall, the site of trouble is determined by performing exploratory gastrotomy. When the ulcer is located, tear through the gastrocolic omentum, insert a finger back of the stomach, invert the posterior wall, look for the ulcer through a gastrotomy wound in the anterior wall, and arrest the bleeding with a ligature or a suture. After arresting the hemorrhage some advocate the performance of gastro-enterostomy to put the stomach at rest and prevent the retention of acid gastric juice. It has been shown that in cases of ulcer in which it is difficult or impossible to reach the seat of bleeding, gastro-enterostomy alone puts the stomach at rest, permits drainage, and strongly favors cure.

Operations for Cancer.—Exploratory incision should be performed in the cases indicated by Murphy and MacDonald. In limited cancer of the body of the stomach, perform partial gastrectomy and remove adjacent involved glands. In cancer involving the entire stomach, the viscus being movable, adjacent organs being free from disease, no demonstrable metastases existing, and the involved glands being obviously removable, complete gastrectomy is a justifiable operation. Pylorectomy is performed in cancer of the pylorus; but only in cases in which there are no extensive adhesions, no metastases, and no involvement of adjacent viscera, and in which the involved lymph glands are removable. In cancer of the cardiac end of the stomach in which the œsophagus is involved, removal by excision is scarcely justifiable and gastrostomy is practically useless. In some cases jejunostomy should be considered. If a radical operation is impossible in cancer of the body of the stomach, no palliative operation is indicated, except possibly jejunostomy. If a radical operation is impossible in cancer of the pylorus, gastro-enterostomy is performed, or, in rare cases, jejunostomy. *John Chalmers Da Costa.*

STOMACH, DISEASES OF.—Within recent years the literature in gastric diseases has grown so extensively that numerous text-books, good, bad, and indifferent, are now issued. Among the best for the practitioner may be mentioned: Riegel, "Die Erkrankung des Magens," Wien, 1896 (an American edition has just been issued, 1903); Boas, "Diagnostik und Therapie der Magenkrankheiten," Leipzig, 1897; Einhorn, "Diseases of the Stomach," New York, 1900; Hemmeter, J. C., "Diseases of the Stomach," Philadelphia, 1903; Van Valzah and Nisbet, "The Diseases of the Stomach," Philadelphia, 1898; Lindner and Kuttner, "Die Chirurgie des Magens," Berlin, 1898; Martin, S., "Functional and Organic Diseases of the Stomach," London, 1895; Gillespie, "A Manual of Modern Gastric Methods," Edinburgh, 1899; Osler and McCrae, "On Carcinoma of the Stomach," Phila., 1900; L. Brunton et al., in Allbutt's System of Medicine, London, 1897.

In preparing the various sections the writers have drawn freely from some of these authors, where special arrangements and topics have appealed to their requirements.*

I. METHODS OF EXAMINATION IN GASTRIC DISEASE.

Inspection.—This includes both a general examination of the patient and a special investigation of the abdomen in general, and the stomach in particular.

The *general examination* concerns the *nutrition* of the patient, the conditions of the *skin* as to dryness and moisture, the evidences of cachexia, etc. The state of the *teeth*, as one of the common causes of gastric disorder, should be examined and due note made of any condition there which may cause infection—*e.g.*, unnecessary bacterial contamination of food, faulty mastication, etc. Often a false set may fit so badly as to be the sole cause of dyspepsia, induced through insufficient mastication alone. The condition of the *gums* is likewise important. So, too, the state of the *pharynx*, more especially in chronic gastritis, in which the morning vomiting is often due solely to pharyngeal mucus swallowed during the night. Salivation, too, is often associated with disease of the pharynx and of the palate and tonsils.

The state of the *tongue* is very much over-estimated as to its diagnostic significance in gastric disorders. It is the mirror of the mouth much more than of the stomach. There may be a clean tongue in cancer of the stomach, while with merely carious teeth there may be persistent coating. As a rule, however, there is apt to be a clean, reddened tongue with hyperchlorhydria, while with subacidity the tongue is usually coated. A dry tongue is usually associated with mouth-breathing.

Examination of the Abdomen.—*Special inspection* of the stomach and abdomen is useful in not a few diseases, for in them it is possible to tell the size, situation, and even the shape of the stomach. This method is best carried out with the patient lying down, as the erect posture renders the recti abdominis rigid. Normally, nothing of the stomach is to be seen.

Among the abnormal conditions which can often be detected by inspection alone are abnormal distention with gas, gastrectasis (idiopathic or obstructive), stenosis of the pylorus (when the tumor is visible and peristaltic waves are evident), hour-glass constriction, peristaltic unrest (a neurosis), and gastroptosis.

Inspection is aided by *inflation* or *insufflation*. This is carried out by one of two methods:

1. Administration of sodium bicarbonate and tartaric acid in separate solutions, the gas forming in the stomach when the two solutions come into contact.

The details of this method are as follows: According to the age and size of the patient, from half a drachm to one drachm of each is placed in separate tumblers which are then filled to one-third with water. The tartaric acid is first administered, and, before the second tumbler is offered, the patient is directed to retain whatever gas may have formed; then the sodium bicarbonate is administered and the patient is told to lie down. With the body in the horizontal position the inflated stomach rises out of the general level of the abdomen, and a satisfactory inspection of the organ can then be made.

Remarks.—An unsatisfactory result may be due to insufficient dosage, the stomach being more capacious than anticipated, or to adhesions, or to its situation chiefly in the left hypochondrium or under the ribs, or to incontinence of the pylorus, or, finally, to excessive gastric peristalsis. Or, again, too much gas may be formed and intense pain and unavoidable emesis follow. The physician should have a stomach tube, a basin, and a towel at hand in case the retention of gas give rise to great pain or to sudden uncontrollable emesis.

2. The second method is the introduction of air by means of the stomach tube, the air being propelled by the double-bulbed Higginson's syringe. This has the advantage of controlling the amount of air introduced and the disadvantage incident to passing the stomach tube. This method should never be tried till the patient has used the tube at least once previously, and air should never be introduced in such amount as to cause severe gastric pain. The contraindications to either of these methods are ulcer, recent hæmatemesis, atrophy of the mucous membrane, peritonitis, and advanced cardiac and arterial disease.

Palpation.—Palpation should be performed gently, systematically, with warm hands, the fingers being held flat on the abdomen at first, and the patient recumbent, breathing gently and with knees flexed. Palpation is easier when the stomach is empty, though tumors and the stomach outlines are often felt best after inflation. Narcotization is sometimes necessary to allow of satisfactory palpation, and is indeed to be strongly recommended in doubtful cases. Any tenderness found should be localized definitely and its degree ascertained. Boas' algesimeter has not been found of any great value in diagnosis.

Tumors of the stomach do not move with respiration, as a rule, the stomach being rather broadened out by descent of the diaphragm. Only when they, or the stomach, are adherent to the solid parts which move with respiration can they be made to descend on inspiration, and with expiration they may often be fixed by intervention of the fingers above the tumor.

Succussion.—Succussion implies detection of fluid with air, in a body cavity, by shaking the patient or the portion examined. The patient lies upon his back and relaxes the abdominal muscles. The physician, then grasping the iliac bones and lumbar muscles on both sides, quickly shakes the patient and a splashing sound is heard. Occurring under certain conditions this is distinctive, but may be simulated by fluid in the colon as well. Presence of this sign in the stomach is only pathological when found to extend over an abnormally large area or at times when the stomach is normally empty (*e.g.*, in gastrectasis, five or six hours after a meal), and should not be otherwise regarded as evidence of disease.

It is doubtful if much reliance for the diagnosis of atony can be placed on the following method: Give the patient half a glass of water and try succussion. If this be obtained it arouses suspicion of atony. Therefore try again in half an hour, and, if a positive result is still obtained, then atony is present. If no succussion be present the motor power of the stomach is normal.

In testing for succussion the triangular area of the stomach in contact with the abdominal wall—*i.e.*, the triangle formed by the midline of the abdomen, the left costal border, and a line joining the cartilages of the ninth ribs—should be especially examined.

Percussion.—This evidence varies according to the amount of contents—food or air. The organ is to a large extent inaccessible normally to percussion—only the above-mentioned triangular area and Traube's semilunar space being easily outlined. Percussion may reveal the size, situation, and shape of the organ and the presence of tumors. Increased area may be due to megalogastria, retracted lung or liver, ptosis, weighty tumors, and dilatation. Diminution in the size of the area may result from left pleural or pericardial effusion, pneumothorax, hypertrophied heart, enlarged spleen or left lobe of liver, etc.

Percussion is much assisted by inflation, less so by administration of fluid.

Auscultation and auscultatory percussion have not as yet proved of any great practical value in diagnosis.

Illumination of the stomach by the gastrodiaphane is sometimes valuable in locating its site, but has little other practical use. As a means of demonstrating the abnormal positions of the organ, it is an excellent method if the patient has a thin panniculus.

Examination of the Digestive and Motor Functions of the Stomach.—For this purpose the best means known is by the examination of the gastric contents after administering a test meal of given quantity and quality. This is more satisfactory and reliable than the older method of examining the gastric juice alone after physical, chemical, or electrical stimulation. It is by no means essential in all cases of gastric disorder to employ test meals or the tube; indeed, the tube is used far more frequently than is necessary or even wise. The cases should be selected according to their needs. After a given test meal has been removed we are enabled to decide from the examination to what extent the motor functions are active, and after analyzing the chemical nature of the contents we can tell to what degree the various constituents of the gastric juice are being secreted as aids to digestion.

Three types of test meals are to be recommended:

1. *Test Breakfast:* One piece of dry bread or toast (60 gm.) and a breakfast cup of weak tea (without sugar or milk). This is to be taken slowly, the bread being well masticated and the tea drunk gradually. One hour later this may be removed and examined.

Such a breakfast should have a residue of not more than 75 c.c.; should be of gruel-like consistence; should contain about fifty per cent. total acidity, free hydrochloric acid ten per cent., combined acid forty-five per cent. Such a meal contains albuminoids, sugars, salts, starches, and extractives, and makes no great demand upon the stomach—a point of importance where there is difficulty of digestion. The disadvantage of such a meal is in the fact that it scarcely demands sufficient effort on the part of the secreting glands of this organ.

2. *The Test Lunch of Germain Sée:* A large piece of bread (120 gm.), a cup of water, and 60 gm. of minced meat. This should be removed for examination two hours later. Little more than 200 c.c. will remain from such a meal, and the total acidity will be about sixty per cent. This meal, containing a more varied diet, still further tests the powers of gastric digestion.

3. *Test Dinner of Leube and Riegel:* This consists of a plate of soup (350 c.c.), 60 gm. of scraped beef, and 60 gm. of wheaten bread. In some meals potatoes in purée form and a tumbler of water are added. This meal should be removed four or five hours later, and will contain a still larger amount of hydrochloric acid (total acidity from sixty-five to seventy per cent.), and it will also give the secretory glands a fair test of their functional powers. Another advantage of this meal is that the macroscopical appearances of the contents give at a glance a fair estimate of the way digestion is proceeding, especially as regards the motor power and the digestive power for proteids. Its disadvantages are the risk of clogging of the tube, the long delay after the meal, and the fact that it is often not readily digested.

Method of Removing a Test Meal.—For this purpose an ordinary stomach tube, thirty-six inches (about 90 cm.) long and of different diameters, should be at hand. One should be careful merely to select one of sufficiently large calibre to allow the pharyngeal muscles to grasp it properly, and not so pliable as to bend in the mouth too easily when introduced. The end should be rounded and provided with two velvet-eye orifices, and it really matters but little whether these be both lateral or one terminal and the other lateral. With ordinary care there is but little danger of injuring the mucosa of the stomach with the tube end. A bulb attached to the upper end of the tube may be of use in removing the contents by suction; but it is not an essential, as the tube itself may be so pressed and pulled as to create suction and thus withdraw the contents. When it is desired to wash

* Sections I., II., III., IV., V., VII., VIII., IX., and X. are from the pen of Dr. Charles F. Martin, while the remaining ones (on "Neuroses," "Simple Tumors," "Displacement of the Stomach," and "Foreign Bodies") have been written by Dr. F. Morley Fry.—*Editor.*

out the stomach a funnel may be substituted for the bulb.

For the operation one requires, in addition, a rubber apron for the patient, two dishes, and a jug of hot water. The patient, seated in an ordinary chair, is then given the tube, which has been previously warmed in water (no other lubricant is necessary), and is directed to swallow it, using his lips to assist in introducing and swallowing the tube. When a gagging sensation supervenes he is instructed to breathe quietly, when he will at once observe the absence of any supposed danger from choking. The head should be held erect, not far backward, and the tongue should not be pressed down. In the case of patients who have a very irritable pharynx, they may be directed, ten minutes beforehand, to suck a pledget of cotton soaked in a five-per-cent. solution of cocaine. The introduction of the tube—when such a step becomes necessary—is to be done as follows: With the left index finger as a guide to the back of the pharynx, the tube held in the right hand is quickly passed down over the epiglottis into the gullet and pushed below the level of the cricoid cartilage. The finger is then removed, the patient told to breathe quietly, and then to continue swallowing the tube. The cardia being eighteen inches (45 cm.) from the incisor teeth, twenty-two inches of tube should be inserted before removal of the contents is attempted.

Three methods of removal are employed:

1. *Expression.* This is best achieved by the patient pressing on his stomach, straining as if at stool, and bending forward—the distal end of the tube being meanwhile lowered over a dish to a point below the level of the stomach. Often the act of retching—voluntary or otherwise—aids the process. Any blocking which may seem to occur may be overcome by pressure on the bulb in such a way as to direct the force of air against the stomach end of the tube (*i.e.*, by compressing the tube on the distal end of the bulb). This is better than to remove the tube and to cleanse it, and illustrates one advantage of the bulb.

2. Failure to remove contents in this way must be overcome by *suction*, either by frequent use of the bulb so as to create a vacuum in the tube by directing the current of air outward, or by filling the funnel with water and allowing it to siphon off in the hope that the stomach contents may follow.

3. Should this method also be without result, *complete siphonage* must be tried. This is done by pouring warm water of a known quantity (say one-half pint) into the stomach, as well as retaining water in the whole length of the tube, and thus removing both the water and the contents of the stomach when the siphonage operates. To do this properly one must lower the funnel quickly before all its watery contents reach the stomach, which would otherwise prevent the action of the siphon. Having thus obtained some contents, we can estimate how much of the meal has remained, after deducting the quantity of water poured into the stomach.

Failure to obtain any contents whatsoever may be due to various factors: The motor power may have been abnormally strong and all food may have passed into the duodenum, as occurs in some neuroses. The time may have been too long after the meal. The tube may not have been pushed far enough into the stomach, and thus not have reached the fluid, or it may have been inserted too far, thus allowing the end with its orifices to curl up again above the level of the fluid. The tube may become blocked with food or mucus.

The contents having been successfully obtained, the tube is removed slowly, and, after being half withdrawn, the distal end should be tightly pinched to prevent the dripping of remaining contents; then the stomach end of the tube should be allowed to slip through the other hand and should be grasped firmly just before its complete removal. This insures less mess in removing the tube and allows greater comfort to the patient. The tube is then placed in warm, mildly antiseptic water and cleansed outside and within. It should never be boiled nor curled up after being cleansed.

There is no occasion to resort to other methods recommended (such as the use of the stomach bucket) for the removal of the stomach contents.

The *contraindications* to the use of the tube for diagnosis are as follows: (1) Recent hæmatemesis; (2) peritonitis; (3) pregnancy; (4) disease of heart and arteries, especially aneurism; (5) febrile conditions; (6) great weakness.

Examination of Stomach Contents.—(1) Macroscopical; (2) microscopical; (3) chemical.

Macroscopical.—The *quantity* depends on the kind of meal and the motor power of the stomach. From this alone we can estimate the presence of motor insufficiency of all degrees—the presence of hypermotility and of supersecretion, remembering always that each test meal has its definitely recognized amount of residue; according to the amount left behind so is the degree of motor (not of digestive) power.

Consistence. One should note, further, the relation of solids and liquids. The food may be only partly digested. A good, evenly mixed, soup-like material implies good secretory power or perhaps hyperacidity. The presence of relatively much liquid, as against a small amount of solids, implies one of two conditions: either retention of fluids from motor insufficiency or hypersecretion of gastric juice. Many coarse food particles imply subacidity, while much starchy remains with well-digested meats show hyperacidity. Sometimes the contents on removal separate into *three distinct layers*, the lowest consisting of starches and chyme, the middle one of cloudy fluid, and the uppermost one of foam, on account of gas formation which usually implies stagnation and fermentation of food. With the foam there may also be remnants of undigested food and mucus. The presence of food taken on a previous day implies, of course, retention of food, *i.e.*, an advanced degree of motor insufficiency.

Odor. Normally the contents have what may be termed a gastric odor. One should note the possible evidence of butyric or of acetic acid, both of which acids are best detected in this simple manner. Abnormal fermentation is implied by their presence. According to underlying causes the contents may have a fetid (ulcerating cancers), fecal (obstruction to intestines, etc.), putrid (phlegmonous gastritis, etc.), or urinous (uræmia) odor. Poisons such as hydrocyanic acid, carbolic acid, etc., may each lend their special odors as signs of their having been ingested.

The *specific gravity* of pure gastric juice is 1.002 to 1.005. In hyperacidity the filtered contents have a specific gravity of 1.010 to 1.020. In subacidity this is often still higher, depending partly on the amount of sugar present.

Mucus is readily seen, and normally there is about one-half drachm in a stringy, gelatinous state. It is gray or colorless, and if pigmented we may conclude that it has come from swallowed sputum or from an associated catarrhal condition. Mucus is increased in hyperchlorhydria, in ulcer, in gastritis, and in certain neuroses of the stomach. In hyperchlorhydria the mucus is often in lumps and threads.

Blood from the stomach is bright or dark, according as a large or small vessel is opened, and according to the length of time it has remained in the stomach. It indicates erosion of a vessel, as caused by ulcer, carcinoma, various forms of gastritis and hepatic cirrhosis, strain or trauma, hysteria, etc.

The vomitus, resembling *coffee grounds*, consists of blood and food-remains, the former being dark from its longer sojourn in the stomach and from the action of the gastric juice. Usually it follows an erosion of the smaller and more superficial vessels.

Pus when present is usually associated with phlegmonous gastritis or an ulcerating cancer.

Bile is commonly present, being regurgitated from the duodenum.

Microscopical.—One sees in the contents the food-remains, consisting of striated muscle fibres, starch grains,

vegetable cells, fat globules, etc. Abnormally there may be sarcinæ ventriculi, characterized by their brown color and their arrangement in multiples of two (bale-shaped); they are usually found with dilatation of the stomach, where hydrochloric acid is present. Yeast cells may be present, as also hosts of bacteria, such as (1) acid forms which do not liquefy gelatin—Bacillus coli, Bacillus lactis aerogenes, etc., and Bacillus butyricus (this does liquefy gelatin); and (2) Bacillus subtilis, Proteus vulgaris, B. fluorescens liquefaciens, Leptothrix, and various micrococci.

The Boas-Oppler bacillus—a thick, long bacillus—is frequently present in advanced motor insufficiency and is commonly found with carcinoma ventriculi, though not an essential feature.

Chemical.—Qualitative Tests. For this purpose the stomach contents should be filtered into a glass beaker, a process which will take time unless the French method of folding the filter paper be adopted. The filtrate is usually clear, slightly yellow, or somewhat opalescent. (Only the most suitable and commendable methods are here given, the various methods being too numerous for the compass of this article.)

The contents are either acid, neutral, or alkaline. If they are neutral or alkaline, one need not go further in testing for acidity; if otherwise, we *first* of all use litmus paper (which is suitable to all free acids, acid salts, and organic acid combinations). If they are acid to litmus, we use, *secondly*, Congo-red paper (a saturated aqueous solution into which white filter paper is steeped), to test for free acids, which if present give to the paper a deep blue. (This is much more sensitive to hydrochloric acid than to the organic acids, while combined acids do not alter the Congo paper.) *Thirdly*, we test for free hydrochloric acid by dimethylamidoazobenzol (one-half-per-cent. alcoholic solution). This yellowish solution is very sensitive to any free mineral acids, and on the addition of a mere trace of free hydrochloric acid a red color appears. Fill one-fourth test tube with the solution, and on addition of a few drops of filtered contents containing free hydrochloric acid the red will appear; 0.002 per cent. of hydrochloric acid will give this reaction. It is the most sensitive reagent as yet known, and though it reacts also to lactic acid and phosphates, it does so only when they are present in concentrated form, which rarely occurs in gastric disease.

Another satisfactory test for free hydrochloric acid must be mentioned, viz., Gunzburg's, whose reagent consists of phloroglucin 2 parts, vanillin 1 part, and absolute alcohol 30 parts. Place on a porcelain dish one drop of this solution, and with it a drop or two of filtered stomach contents. Heat gently over a Bunsen burner, and if free hydrochloric acid be present a rose-red color will appear; a brownish-yellow color is meaningless.

Test for Combined Hydrochloric Acid.—Where free hydrochloric acid is found the combined hydrochloric acid is implied; but should the former be absent, there may still be sufficient acid secreted to fulfil some of the requirements of proteid digestion. This is ascertained by a color test with alizarin (one-per-cent. aqueous solution). Filter the stomach contents, place a few cubic centimetres in two separate test tubes. To one tube add a few drops of alizarin and a decinormal solution of sodium hydrate till a pure violet color appears. Note the amount of NaOH used. To the second tube add the same quantity of one-tenth NaOH, and, if it is found still acid to litmus, combined HCl is present.

The biuret reaction, however, is simpler and shows equally well the presence of combined acids by proving the presence of peptone or propeptone in the filtered contents. Take, therefore, a few cubic centimetres of the stomach contents in a tube, add to this a few drops of caustic potash, and then, by means of a pipette, drop by drop, a ten-per-cent. solution of copper sulphate. The green color produced becomes a violet on addition of the last reagent. This is known as the biuret reaction. Propeptone would not form without hydrochloric acid being present. Failure to obtain a positive test for free hydrochloric acid, followed by a positive biuret reaction, indicates the presence of combined hydrochloric acid.

Quantitative Tests.—The total acidity is made up by the acidity from mineral and organic acids in a free or a combined state. Normally, this forms rarely more than 0.25 per cent., though, according to the time after meals, this varies, the most being found three hours or so after a mixed meal.

A decinormal solution of NaOH is used in a burette. Ten cubic centimetres of filtered contents of the stomach are placed in a beaker and one or two drops of phenolphthalein are added as an indicator. Excess of alkali renders the color red. The NaOH solution is added till the red color appears in the gastric contents, and the amount necessary to produce this result is read off on the burette. Normally from 4 to 6 c.c. are required for 10 c.c. of gastric contents; *i.e.*, 40 to 60 c.c. would be necessary for 100 c.c. Hence one speaks of forty to sixty per cent. total acidity. The exact amount of acid is calculated as follows:

1 c.c. of normal NaOH = 1 c.c. normal HCl.
1,000 c.c. of normal NaOH = 1,000 c.c. normal HCl, *i.e.*, 36.5 (molecular weight of HCl in grams to 1 litre of water).
∴ 1 c.c. of normal NaOH = 0.0365 HCl.
∴ 1 c.c. of decinormal NaOH = 0.00365 HCl.
∴ 40 to 60 c.c. of decinormal NaOH = 0.146 per cent. to 0.219 per cent. (= normal percentage of total acidity).

For all practical clinical purposes this test suffices and gives a fair idea of the proportion of hydrochloric acid present, inasmuch as most of the acidity present is due to this acid.

Test for Free Organic Acids.—Lactic acid: Uffelmann's test is the simplest, and, though not infallible, is, on the whole, the most practical. A solution is made consisting of one or two drops of Tinctura ferri perchloridi and 10 c.c. of a 1-to-40 solution of carbolic acid. This forms an amethyst blue color (if darker it should be further diluted with water); a few drops (ten or fifteen) of the filtered stomach contents are added to this solution, and if lactic acid be present the solution will show a greenish-yellow or canary-yellow color. (Anything less than a definite yellow tinge is without meaning.)

Inasmuch as combined hydrochloric acid is apt to give a yellowish-brown color with this solution, it may at times serve better to omit the carbolic acid and use merely a couple of drops of dilute iron perchloride. Lactic acid added to this more or less colorless solution gives a light yellow tint. (Phosphates, sugar, and alcohol must be excluded, as they give a similar reaction.—Gillespie.)

The Volatile Organic Acids.—After distilling off three-quarters of the stomach contents, the rancid butter smell of butyric acid and the characteristic acetic odor of acetic acid are readily detected. The more elaborate means of detecting them are of little value.

Examination for the Enzymes.—The ferments are much more constant than is the hydrochloric acid, as they are uninfluenced by circulatory or nervous disturbances, and any persistent alteration in their quantity or action implies a greatly altered function of the glands of the stomach. They assume importance only when hydrochloric acid is deficient. By knowing of the presence of enzymes, we can tell if the glands are temporarily or permanently damaged. Absence of hydrochloric acid is common in many gastric conditions, but is unaccompanied by any appreciable change in the secretion of pepsinogen. When the latter is absent it implies an advanced gastritis or atrophy of the mucous membrane. A knowledge of the enzymes thus affords us aid in prognosis and treatment, though the value thereof is certainly limited.

Test for Pepsinogen.—It is converted into active pepsin in presence of HCl, and thus can convert albumins and albuminoids into soluble substances.

Qualitative Test.—If the filtered contents of the stomach contain HCl and digest albumen, pepsin is present; or if, having no HCl, they digest albumen after HCl is added, pepsin is present. If the filtered contents have

no HCl and do not digest albumen after HCl is added, then pepsin is absent.

Quantitative Test.—Add to 10 c.c. of stomach contents a small egg disc or dried fibrin, and place in a thermostat at 37° C. The egg or fibrin will become dissolved. According to Jaworski, 5 to 6 c.c. of egg disc added to 25 c.c. normal stomach contents (filtered) will digest in three hours. This is a fair quantitative test. Hammerschlag's is more accurate: Make up 20 c.c. of one-per-cent. albumen solution, containing three per cent. HCl, and divide into two test tubes. To the one (the control) add 5 c.c. H_2O, to the other add 5 c.c. filtered stomach contents. Let stand one hour in an incubator at 37° C., and test the amount of albumen by Esbach's method. The control contains the original amount of albumen, the other less, and the difference between them represents the amount of albumen digested; *e.g.*, if the control has six per cent. albumen and the other three per cent. albumen, then we have fifty per cent. of albumen digested.

The Rennet Ferment (Labzymogen).—This ferment clots milk even in faintly acid or neutral media. The simplest test is Leo's: Add three to five drops of filtered contents to 5 to 10 c.c. of milk; place in the thermostat, and clotting will occur in fifteen minutes.

The Motor Power.—The fasting stomach contains but little fluid. The highest estimate places the amount at 100 c.c. Most authorities regard 20 to 30 c.c. as the normal. This fluid is pure gastric juice and should have normally no food residuum. The tests suggested for this have been very numerous. The best and one of the simplest is to ascertain from a test meal the amount of residue in a given time. Thus, one hour after the test breakfast there should not be more than 100 c.c. of contents; two hours after the meal of Germain Sée there should not be more than 175 c.c., while five hours after Riegel's meal 200 c.c. would be regarded as the limit for a normal stomach. Anything exceeding this implies deficient motor power. There are three degrees of motor insufficiency:

1st. The stomach contents are delayed, but evacuated some time before the next meal.

2d. The stomach is empty only just before the next meal or in the early morning. This is stagnation.

3d. The stomach is never completely empty even in the early morning. This is called retention.

The smaller test meals will suffice for diagnosing the first two conditions. To test for the third degree it is well to wash out the stomach at first before giving the Riegel dinner (which should be administered in the evening), and then again to test in the early morning for what residue may be present. If food has remained, the third degree of motor insufficiency is present.

II. MINOR AILMENTS.

General Symptomatology in Diseases of the Stomach.

Indigestion or Dyspepsia.—These terms may reasonably be applied to a series of cases which every physician meets, and that very frequently—cases which, though probably associated with a slight temporary anatomical, secretory or other functional abnormality, nevertheless show little or nothing upon careful physical examination of the stomach, nor any serious alteration in the chemical constituents of its contents after a test meal. Nor, again, is it other than an admission of ignorance to assign these cases in all instances to a pure neurosis.

In health we are unconscious of the presence of digestion and do not realize the fact that we possess a stomach. When dyspepsia occurs, however, much of what we eat occasions such inconvenience as to make us only too cognizant of the fact that digestion is in progress, and that we possess a digestive organ which is functioning badly. The disturbances are usually present after eating, and are most frequently associated with some temporary derangement of the motor or secretory powers.

They may appear before meals and be relieved by eating; and, when such is the case, the causative factor is usually an increase in the amount of acid secreted. Sometimes, again, the nerves alone seem accountable for the disturbance, while at other times a defective circulation from organic or functional cardiac disease, or vaso-motor trouble, is the main etiological factor.

The symptoms most frequently present are as follows: A bad taste in the mouth with a disagreeable odor of the breath; a coated tongue; anorexia, or more rarely boulimia; oppression and weight in the stomach; flatulence and a sense of distention; pains of various characters; heartburn, pyrosis, water brash, acid eructations; nausea and vomiting; dyspnœa and palpitation; cough; constipation and diarrhœa; vertigo.

Any or most of these symptoms may be present with serious disease of the stomach, in which case they may be the main premonitory signs; or, on the other hand, they may be merely the symptoms of an ordinary dyspepsia of a purely temporary character.

The Causes of Simple Indigestion and Minor Ailments of the Stomach.—1. *The Food.*—The *quantity:* This should be sufficient to supply the demands of nutrition, and in order to maintain a normal digestion this should be neither too much nor too little.

Excessive Quantity.—In childhood, when too much is persistently taken, the effects are of a less serious consequence than in adult life.

Excess of food is injurious in various ways: the stomach having too much to do is easily overworked and the muscle becomes to some extent paretic. As a result it never completely empties itself, and is kept persistently busy without the necessary rest. This of course is particularly injurious at night, for which reason the custom of taking heavy suppers is baneful, all the more so as digestion is delayed during sleep and the overloaded stomach has a double reason for becoming diseased. The fact that many people can stand excesses in diet for years with impunity does not render this rule any the less true. Usually such dietetic errors are amply paid for in the latter years of life, even though individual predisposition may count for much, as also the habits of life in general, the occupation, and the daily hygiene.

Excess of food is not always the result of individual large meals, but often the consequence of a too rapid succession of individual meals, or their irregularity and multiplicity.

Insufficient Quantity.—Too little food, on the other hand, is not an infrequent cause of dyspepsia, the so-called starvation dyspepsia. It is often the outcome of some other digestive trouble, whereby the patient imagines that a strictly limited diet is necessary, not wholly as regards quality but likewise as regards quantity. Rich and poor alike suffer from this cause; the rich from errors of judgment, the poor from necessity, often laboring without a quantity of food sufficient to keep up the metabolism.

In some cases of dyspepsia it is advisable to give small and frequent meals, but such should always be given with due regard for their caloric values. In all cases, whether food is given in limited amounts or in excess to satisfy the needs of the patient, regularity in the time of meals should be carefully considered, in order to give the stomach its proper time for rest.

The Quality of the Food.—This is of equally great importance. The digestibility of foodstuffs depends upon the quality, both chemically and physically. Thus, for example, the food should never be so tough as to render complete mastication difficult; hence the need of avoiding foodstuffs which are too coarse or of too hard a fibre (as in the case of meat when old), or insufficiently cooked. Mastication is thus rendered difficult, and the saliva and secretory juices fail to come into contact with the individual particles. These undigested masses remain thus irritants to both the stomach and the intestines.

Such a condition of course is aggravated by imperfections or absence of the *teeth*, more especially the molars.

The *cooking* of the food is of the greatest importance. It is a well-recognized fact that boiling renders meats more digestible than does any other form of preparation, and for the simple reason that they thus become more disintegrated. Roasting and broiling come next in importance, while frying prepares meats and other foods in their most indigestible form. Fried foods are covered over with fat, which thereby renders them more or less impermeable to the juices of digestion.

Again, too much of *one kind of foodstuff* is likewise bad. Thus, for example, an excess of proteids over any other kind of food would exact too much of the gastric juice, and thereby both directly and indirectly injure metabolism. Upon the other hand, if carbohydrates be taken in excess, fermentation is apt to occur and organic acids are introduced in excess into the alimentary tract.

The *temperature* of foods is likewise of some importance, and excesses here, as in other particulars, are injurious. Food when taken too cold, as in the shape of ices and ice water, interferes with the proper functions of the stomach, as do also foods of various kinds when taken persistently too hot.

The ingestion of too much fluid is bad, as it renders the food pappy in the mouth, dilutes the gastric juice, and thereby increases the liability to fermentation and indigestion. Much fluid is particularly injurious in motor insufficiency, which is termed by some the dyspepsia of fluids, for in this condition fluids are with difficulty passed on into the duodenum and the water is itself not absorbed in the stomach.

On the other hand, where hydrochloric acid is secreted in excess and the motor power is good, water taken freely with meals is of benefit, diluting the excessive acid present and relieving the distressing symptoms.

A glass of hot water taken before meals, or a glass of cold water in the early morning, even for healthy people, will aid digestion.

There are many foods which custom impels us to take but which should be classed among those which are a menace to healthy digestion; such, for example, as foods which are too rich, or again too spicy, in which category we place excess of vinegar, the persistent use of pickles, and the like, which induce a chronic dyspepsia and consequent emaciation from malnutrition.

The same holds true of acid wines. Spirits, too, in excess are to be condemned, especially when taken on an empty stomach. In those in whom flatulence is common beer is injurious, especially so if recently brewed, because fermentation is thus incomplete, and is continued after the beverage has found its way into the stomach.

Tea should always be taken weak; when long infused it contains an excess of tannin, which being an astringent interferes with the secretions of the stomach, especially with the digestion of proteids.

Unripe fruit, being mainly tough cellulose, is likewise irritating.

2. *Bacteria.*—These at times contribute toward indigestion. Their invasion of the teeth and mouth, if not prevented or contended against, is liable to produce slight functional disorders, among which loss of appetite, a disagreeable taste in the mouth, fermentation in the stomach and its consequences, may here be mentioned.

3. *The secretory or motor power* of the stomach itself may be defective, temporarily and only to a slight degree, acting thus as the main factor in dyspepsia.

4. *The nervous system* may be a primary etiological factor. Excitement, emotion, grief, etc., may each contribute toward the production of a more or less ephemeral indigestion.

5. *Circulatory disturbances*, associated with organic or functional disturbances or vaso-motor conditions, may each in themselves act as causes.

6. *Malposition of the viscera, adhesions within the abdomen*, etc., may act in the same way.

7. *Inactivity* is a very important factor, resulting as it does in imperfect combustion and its results.

Symptoms in Detail.

Coated Tongue.—The tongue may be coated with a fur of varying colors, from a whitish hue to a brownish-black; its thickness may vary in degree, as also its consistence and moisture. The coating is made up mainly of epithelium, bacteria, and detritus. It may be localized at one or other parts of the tongue. It is a fallacy to believe that the tongue is a mirror of the stomach, for in a large majority of cases faulty digestion in the stomach has but little to do with the coating seen upon the tongue. Much more frequently are the causes to be found on the teeth or on the pharynx or tonsils. Frequently a stomatitis is the main cause, or, again, excessive smoking.

Under other conditions a coated tongue may be due to disease of the stomach and intestines; it does not as a rule carry any diagnostic value. In many diseases of the stomach, which are of extreme gravity, the tongue is clean. This may frequently be the case with ulcer of the stomach or with a condition of hyperacidity, in which case the tongue is especially clean at the tip, and often is quite sore. In alcoholics too there is often a reddened sore tongue which is uncoated.

The Breath.—The breath may be foul or disagreeable, and this may be subjective, obvious only to the patient; or it may be objective, *i.e.*, only the patient's friends observe the affection. At times the condition is associated with defects in the mouth, pharynx or larynx, and respiratory passages. The odor may arise from the stomach. It may be of sulphureted hydrogen and due to the occurrence of putrefaction or decomposition in that organ. Sometimes this is accompanied by eructations of either gases or liquids, while at other times no obvious cause can be found to account for the peculiar disturbance.

The Appetite.—Though related to gratification of the nerves of taste in the mouth, and usually an expression of the need of the body for food, the appetite, when abnormal, may be merely an indication of the need of the gastric juice, or again an evidence of a perverted nervous system, or of an altered state of the metabolism. In health it is a definite indication of the caloric requirements. Just exactly how the sensation of appetite is induced is unknown. It is a nervous phenomenon associated with the brain, and dependent in a reflex way often on conditions of the stomach. Perhaps, as Brunton suggests, it is connected with distention of the lymphatic spaces in the mucous membrane, analogous to the itching which appears before sweating takes place. Some regard the swallowing of the saliva and its stimulation of the gastric secretions as the main factor.

The state of the circulation, however, seems to have some influence upon the appetite, and Beaumont has shown that a craving for food was present when the mucous membrane of the stomach was red. Variations again may be due to alteration of the nerves of taste and to disease in the mouth itself.

Anorexia (*'av, ὄρεξις*), diminished appetite, depends on many conditions. Many people eat too much and too often, a result being that these excesses soon lead to an impairment of the appetite.

The cause may be (*a*) in the stomach, (*b*) in the nervous system, or (*c*) in constitutional conditions.

(*a*) So far as the stomach is concerned, motor insufficiency is the most important factor, unless increased hydrochloric acid be present.

Other causes, again, are organic disease of the mucous membrane, acute and chronic gastritis, cancer, atrophy of the glands, etc.

It is important to remember that in cancer the appetite may remain good if the motor power be unaltered, especially in cancer of the body of the stomach, and the patient may even gain in weight.

Sometimes in disease of the stomach it is not so much the diseased condition as the fear of pain which induces anorexia—such, for example, is the case in gastric ulcer.

(*b*) With regard to the nervous system as a cause there