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What is the Matter with the American Stomach?

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MODERN MEDICINE PUB. CO., Battle Creek, Mich.

WHAT IS THE MATTER WITH THE AMERICAN STOMACH?[1]

NEW AND EXACT METHODS OF FINDING OUT.

BY J. H. KELLOGG, M. D.

SOME years ago a leading English practitioner remarked to me in London, "Doctor, I suppose that in America the business of physicians is chiefly confined to the treatment of indigestion." I replied that I had heard that Americans enjoyed the unenviable reputation of being a nation of dyspeptics; but yet we did sometimes encounter other pathological states than those of indigestion. Nevertheless, as the remark of the London physician has at intervals occurred to me, I have found myself recognizing more and more distinctly the fact that, after all, the practice of medicine, outside of surgery and obstetrics, for the most part revolves about the stomach.

Bouchard has shown the important relation of ptomains developed in a dilated, or atonic, stomach to chronic rheumatism, to bronchitis, to anginal cardiac affections, to albuminuria and renal diseases, to pulmonary phthisis, to jaundice, and to skin diseases. He has also shown the intimate relation which exists between putrefactive and fermentative processes taking place in any part of the alimentary canal, resulting in the production of ptomains and other toxins, to puerperal fever and febricula.

M. l'Gendre has shown the relation of dilatation of the stomach to typhoid fever, to tapeworm, to lumbrici, and other intestinal parasites, great and small.

Vigoroux asserts that the great number of functional nerve disorders which are included under the general term "neuras-

[1] Presented at the Annual Meeting of the Mississippi Valley Medical Association, held at Detroit, Mich., Sept. 4-6, 1895.

thenia" are all of gastric origin; that neurasthenics without exception are suffering from uric acid poisoning. Excess of uric acid in the tissues is, according to Bouchard, due to an abnormal slowing of the processes of oxidation and disassimilation, which results from a toxemia arising from the absorption of the products of. putrefaction and fermentation in the alimentary canal.

Dana asserts that organic changes in the central nervous system are doubtless due to the absorption of toxic substances produced by microbic processes in the alimentary canal.

Thus we see that special investigators in the etiology of disease are from all quarters pointing toward the stomach as the starting-point of the train of morbid processes which give rise, in each particular case, to a special group of morbid manifestations. Unreasonable as this may at first seem, a glance at a few simple physiological facts may serve to dissipate the apparent absurdity.

The function of a tissue or organ depends upon its structure. The structure of every cell and fiber of the body depends upon the quality and quantity of the material absorbed from the alimentary canal. A deficient supply of food weakens the structure, and lessens the energy of every organ. An excess of food overwhelms the tissues with imperfectly oxidized and toxic substances, whereby their structure is deteriorated, and their functions perverted or retarded. Food containing toxic substances produces upon the body general or specific toxic effects. The same results from the development of toxic substances in the alimentary canal from the fermentation or putrefaction of food in the stomach and intestines. Pasteur, David, and others have shown that the mouth, the stomach, and the intestines are continually inhabited by a vast number of microbes capable of generating various acids, poisonous ptomains and toxins, varying in their physical and physiological properties, and some of them capable of producing most powerful poisonous effects. These poisons are generally produced in greater or less quantities; but thanks to the poison-destroying power of the liver and the eliminative function of the kidneys, the amount at any time circulating in the tissues of a healthy man is not sufficient to produce any more deleterious effect than that gradual deterioration of the organism by which the tissue-modifications characteristic of old age are brought about. When, however, diseased conditions of the stomach or intestines exist, these poisons may be increased to an enormous degree ; for example, Bouchard has shown that if food is retained in the stomach more than five hours, the changes which take place are fermentative and putrefactive, rather than digestive. This explains the relation demonstrated by Bouchard and others between dilatation of the stomach and chronic rheumatism and the lowered vital resistance which prepares the way for tubercular disease of the lungs and other structures.

A catarrhal condition of the stomach and intestines encourages general toxemia and the development of an infinite variety of pathological conditions, by furnishing, in the masses of the mucus retained in patches upon the mucous surface, hiding-places for microbes, in which they are protected from the germicidal action of the digestive fluids. The particular form of morbid manifestation which may arise from the poison thus engendered depends upon the special properties of the poisons which may happen to be formed in the greatest abundance, and upon the susceptibility of the individual tissues. Modifications of conditions may render poisons which at one time are comparatively inert, at another time highly toxic ; for example, Klebs has shown that the highly toxic poison of cholera nostras is derived from guanidin, a comparatively slightly toxic substance always present in the tissues ; and Griffith has shown that the toxins of scarlet fever and diphtheria which are founa in the urine of patients suffering from these diseases are derived from creatin, a poison always present in the flesh of animals, but possessed of comparatively small toxic power. These facts explain the influence of habits and conditions of life in producing susceptibility to disease, and in determining the fatality of maladies.

A perfectly healthy man is proof against germs. Cholera germs, typhoid-fever germs, and other disease-producing microbes may be swallowed with impunity by a person whose alimentary canal is intact. The gastric juice of a healthy stomach is capable of destroying every germ that lives. Bile serves the purpose of an antiseptic for the intestines, as the gastric juice does for the stomach.

One of the most important functions of the stomach seems to be the disinfection of food. The idea that microbes and putrefactive processes are essential as an aid to digestion is an error which is supported by neither physiological proof nor bacteriological facts. The normal stomach is perfectly capable of taking care of itself, provided it has a favorable opportunity, as I will attempt to show later in this paper. Nature has thus undertaken to protect the body against the destructive influence of the poisons which might develop in the alimentary canal by means of the germicidal power of the gastric juice and the bile, and has afforded a protection against both the poisons which might be actually introduced with the food, and those which might result from bacterial action in the alimentary canal by means of the poison-destroying and the poison-retaining property of the liver, as well as by the marvelous eliminative activity of the kidneys.

So long as these protective agencies are in active operation, the body retains its ability to resist the attacks of microbes, and, provided other conditions are normal, the vital resistance of the body is sufficient to cope with natural disease-producing agencies. When the protective agencies are crippled; when the stomach no longer secretes a gastric juice capable of destroying microbes; and when it becomes, by dilatation or motor insufficiency, the hold of every unclean and hateful germ, the flood-gates of disease are thrown wide open, the portals of the vital citadel are unguarded, and the exciting and predisposing causes of almost every ill to which human flesh is heir are set in operation. A clinical recognition of this fact has led many a wise old physician to insist upon the supreme importance of materia alimentaria as compared with materia medica, and to recognize the paramount importance of attention to the digestive functions in the treatment of maladies of every description.

Granting the force of these considerations, it becomes a matter of grave importance that we should enquire with great solicitude, What is the matter with the American stomach? That something is the matter is evidenced not only from the facts and arguments which have been presented, but from the facts which may be gleaned from a glance through the advertising pages of any medical journal, newspaper, or popular magazine, or by an inventory of any druggist's shelves or counters. The vast predominance of medicaments intended in some way to aid the digestive organs, over all other remedies either regular or irregular, is a patent fact. Pepsin is manufactured and sold by the ton. Peptones, peptonoids, malt preparations of various kinds, diastatic and other digestive ferments of every possible form, are manufactured and sold in enormous quantities, and swallowed with avidity by the victims of digestive disorders, in the vain hope of finding relief. The questions of most practical interest in this inquiry, are —

1. What are the causes of this general failure in digestion recognizable among the adult population of the United States?

2. By what means may the functional disorders of digestion and their consequences be remedied?

This subject is altogether too large to be comprehensively treated in a single paper, but I wish to call especial attention to the results of some investigations which I have undertaken, looking toward the solution of these questions, and which I believe throw some light upon them.

From Hippocrates down to the present time, medical literature has abounded with maxims relating to eating and other matters pertaining to digestion. Some of these are recognized as the natural outgrowth of experience. Others may have only a whimsical basis, or no other foundation than the fancy of some prejudiced observer, the prestige of whose authority, however, has been sufficient to give him a certain degree of permanence. The purpose of my inquiry has been to bring to bear upon the etiological and therapeutic questions relating to indigestion, the precise methods which recent advances in the methods of physical diagnosis pertaining to the stomach have enabled us to utilize.

NEW MODE OF INVESTIGATING DISORDERS OF DIGESTION.

Before detailing the experiments which I have made, I will briefly describe the method of investigation of the functional activities of the stomach employed by me. Some fifty years ago, Golding Bird, of Guy's Hospital, London, discovered the interesting fact that free hydrochloric acid may be separated from the gastric juice by distillation. Hayem and Winter, of

Paris, developed from this fact a method of investigation of the digestive work of the stomach by which it was possible to determine not only the total amount of chlorin secreted by the stomach, but the exact relation of the different forms of chlorin, — free, combined, and fixed, — thus measuring the quantity and quality of the work done by the stomach in the digestion of proteids. Taking the work of Hayem and Winter as a basis, and adding thereto the results of the investigations of others, and the advantages of the experience gained in the careful chemical study of over five thousand stomach fluids, I have elaborated the method of studying stomach fluids which is illustrated in the blank for recording results which is shown herewith. The first page of this blank affords opportunity for recording (1) the physical and microscopical characters of the stomach fluid obtained after a test meal; (2) the colorometric and other qualitative reactions relating to the digestive agents; (3) the digestive products and fermentation products; (4) the quantitative chemical determination relating (*a*) to digestion of albumen, (*b*) digestion of starch, (*c*) the fatty acids, and (*d*) the coefficients of the digestive work done. Of these coefficients I have established seven, as follows: —

1. Relating to the digestion of albumen.
2. Relating to the digestion of starch.
3. Relating to the activity of the saliva.
4. Coefficient of fermentation.
5. Coefficient of solution.
6. Coefficient of absorption.
7. Coefficient of chlorin liberation.

On the fourth page of the blank is shown a graphic method of recording the results obtained by these exact determinations. On pages 2 and 3 is presented a classification of the functional disorders of digestion based upon a chemical examination of the stomach fluid obtained after a test meal in over five thousand analyses.

Considered in relation to the amount of work done, there are four general classes of indigestion: Hyperpepsia, in which there is excessive stomach work; hypopepsia, in which there is deficiency of stomach work; apepsia, in which there is no digestive activity whatever; and simple dyspepsia, in which the

CLASSIFICATION OF FUNCTIONAL DISORDERS OF THE STOMACH,

IN RELATION TO PROTEID DIGESTION,

Based upon a Quantitative Chemical Examination of the Stomach Fluid Obtained after a Test Meal, in over 5,000 Analyses.

By J. H. KELLOGG, M. D.

The symbols under each head indicate the characteristics of each individual form of quantitative disturbance to which the stomach is subject.

HYPERPEPSIA. $A' +$.

1. $A' + H + C +$ Typical........ (Both HCl and combined chlorine in excess.)
   - 1. $a =$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$.
   - 2. $a -$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$.
2. $A' + H\,0, -$ or $= C +$......... (Without excess of free HCl [H].)
   - 1. $a =$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$.
   - 2. $a -$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$.
3. $A' + H + C -$ or $=$.......... (Without excess of combined chlorine [C].)
   - 1. $a =$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$.
   - 2. $a -$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$.

HYPOPEPSIA. $A' -$.

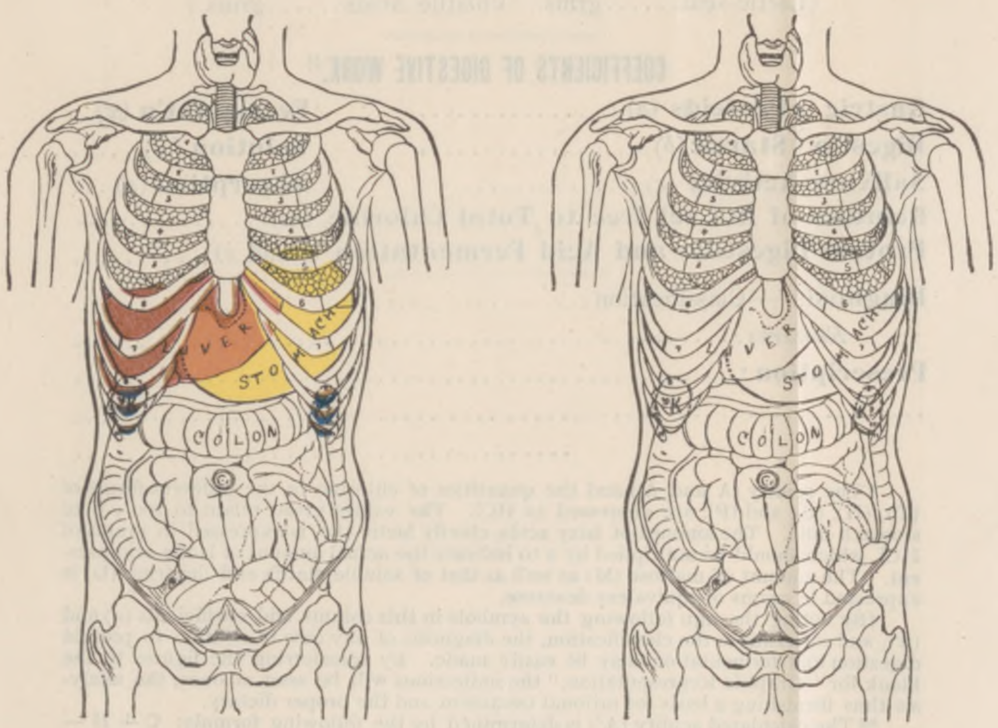
1. $A' - H -$ or 0 Typical......... (All elements deficient.)
   - 1. $a =$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$
   - 2. $a -$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$
2. $A' - H =$ or $+$ .... (Without deficiency of HCl [H].)
   - 1. $a =$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$.
   - 2. $a -$
     - 1. Without fermentation $(x\,0)$.
     - 2. With " $(x +)$.

APEPSIA. A o or — a o or — H o.

1. Without fermentation $(x\,0)$.
2. With " $(x +)$.

SIMPLE DYSPEPSIA. $A' =$.

1. $a =$
   - 1. Without fermentation $(x\,0)$ (normal).
   - 2. With " $(x +)$.
2. $a -$
   - 1. Without fermentation $(x\,0)$.
   - 2. With " $(x +)$.



Results of Physical Examination Respecting the Position of the Stomach and other Abdominal Organs.

EXPLANATION OF CLASSIFICATION.

In the study of over 5000 stomach fluids, I have found it possible to include all cases of disorder of the chemico-vital processes of the stomach, as regards proteid digestion, in four general classes: *Hyperpepsia, hypopepsia, apepsia,* and *simple dyspepsia* (following the classification of Hayem and Winter). Hypopepsia and hyperpepsia present respectively two and three main subdivisions, each of which, together with simple dyspepsia, is divided into two tpyes, according as coefficient (a), the measure of the quality of proteid digestion is, = or —. Each of these types, together with apepsia, is again subdivided in relation to fermentation, into two classes, without fermentation and with fermentation. The characteristics of these several classes, subdivisions, and types are as follows: —

HYPERPEPSIA.

The characteristic feature in hyperpepsia is $A' +$. The significance of this is that the free HCl and combined chlorine ($H + C$) are found in quantities sufficient to produce nominal hyperacidity, there being excess of stomach work, not regarding quality. There are three subdivisions: —

1. Hyperpepsia typical, all kinds of work in excess ($A' + H + C +$).
2. Hyperpepsia without excess of HCl ($A' + H -$ or $= C +$).
3. Hyperpepsia without excess of combined chlorine ($A' + H + C -$ or $=$).

Each of the subdivisions of hyperpepsia presents two types: —

(1.) $a =$, signifying that the proteid digestion is normal in quality.
(2.) $a -$, signifying that the proteid digestion is inferior in quality, neutral chloro-organic compounds being present.

Each type is subdivided, with reference to fermentation, into two classes: —

[1.] Without fermentation (x o).
[2.] With fermentation ($x +$).

HYPOPEPSIA.

The characteristic of hypopepsia is $A' -$, the significance of which is that H and C are not found in sufficient quantities to produce a normal degree of acidity. There are two subdivisions of hypopepsia: —

1. Hypopepsia typical ($A' - H -$).
2. Hypopepsia without deficiency of HCl ($A' - H =$ or $+$).

Each of the subdivisions of hypopepsia presents two types: —

(1.) $a =$, signifying that the proteid digestion is normal in quality.
(2.) $a -$, indicating the presence of neutral chloro-organic compounds.

Each type is subdivided, with reference to fermentation, into two classes: —

[1.] Without fermentation (x o).
[2.] With fermentation ($x +$).

APEPSIA.

In apepsia there is no normal proteid digestion. The characteristics are a neutral or very slightly acid stomach fluid (A o or —); the coefficient of proteid digestion is zero (a o). There are two subclasses in apepsia: —

1. Without fermentation (x o).
2. With fermentation ($x +$).

SIMPLE DYSPEPSIA.

The characteristic of simple dyspepsia is $A' =$, the significance of which is that H and C are present in sufficient quantities to produce a normal degree of acidity. Simple dyspepsia presents two types: —

(1.) $a =$, signifying that the proteid digestion is normal in quality.
(2.) $a -$, signifying that neutral chloro-organic compounds are present.

Each type is subdivided, with reference to fermentation, into two classes: —

[1.] Without fermentation (x o).
[2.] With fermentation ($x +$).

For convenience in writing prescriptions these general classes are designated as follows: Hyperpepsia, Hyp.; hypopepsia, Hop.; apepsia, Ap.; simple dyspepsia, Sp.

The subdivisions under each class are designated by number as follows: Hyp. 1-1-1 would indicate a case falling under the first subdivision of hyperpepsia, of the first type ($a =$), without fermentation; Hyp. 3-2-2 would indicate a case belonging to the third subdivision of hyperpepsia, second type ($a -$), and with fermentation; Hop. 2-1-2 would indicate a case of the second division of hypopepsia, of the first type ($a =$), with fermentation; Ap. 2 would indicate a case of apepsia with fermentation; Sp. 1-2 would indicate a case of simple dyspepsia of the first type ($a =$), with fermentation.

Explanation of Symbols.—The quantities which are utilized as a basis for the classification of cases in relation to proteid digestion, are A', H, C, L, a, and x. The significance of these several symbols is as follows: —

A represents the total acidity as determined by acidimetry.

A′ represents the acidity indicated by the amount of free HCl and combined chlorine present ($H + C$), the combined chlorine being taken at its full value. The value of A' in a given case is determined by simply adding the quantities represented by H and C. This value shows the quantity of work done without reference to quality, and is the basis for the division of cases into the four great classes: *Hyperpepsia, hypopepsia, apepsia,* and *simple dyspepsia.*

H represents the quantity of free HCl found by quantitative estimation.

C represents the amount of combined chlorine present in a given case when the proteid digestion is normal in quantity. The combined chlorine represents the same degree of acidity as the free HCl. There is likely to be present, however, a greater or smaller quantity of neutral chloro-organic compounds, which, possessing no acid value and no nutritive value, give to C, as determined by the estimation of chlorine, a value greater than it really possesses. The true value of C is shown by a, the coefficient of proteid digestion.

L represents the amount of lactic acid found present, expressed in terms of HCl. The actual amount of lactic acid is twice that indicated, but its acid value alone is of interest in this connection.

a, the coefficient of proteid digestion, represents the real value of the work done. It is determined by the following formula: $\frac{A - (H + L)}{C}$. a is simply a numerical expression of the nutritive value of the combined chlorine represented by C, its true acid value and its nutritive value being considered as identical. As the value of the combined chlorine is rarely found at par, the coefficient is considered to be normal when it does not fall more than 10% below par (.90 to 1.00 is considered as $a =$).

x is the coefficient of fermentation and indicates the amount of fatty acids present. It is based upon an actual determination of the amount of lactic acid and volatile fatty acids present. When this amount is less than .005 grams per 100 c.c., the case is considered normal (x o). If a larger quantity of fatty acids is found present, the case is considered to be one in which fermentation is present ($x +$).

m is the coefficient of HCl formation. It is obtained by the formula $\frac{T - F}{T}$, in which T represents the total chlorine and F the fixed chlorine. The normal relation of the chlorine set free from the basis, to the total chlorine is .66. To put the result on the basis of 100, in harmony with other coefficients, it is only necessary to divide the figures obtained from the formula by .66, or multiply by .015.

a and **x** as a mixed coefficient: In cases in which a sufficient amount of stomach fluid for the quantitative estimation of the fatty acids (lactic, butyric, etc.) cannot be obtained, approximate information in regard to the presence or absence of fermentation, and the amount of fatty acids present, may be obtained by the formula $\frac{A - H}{C \times .90}$. If the result is greater than unity (1 +), fatty acids are probably present; certainly so if the figures are much above unity. If the result is less than unity (1 —), fatty acids are either not present or the quantity present is insufficient to neutralize the neutral chloro-organic compounds represented in C, and consequently cannot be very great. When determined in this way, the coefficient is mixed, and relates to both fermentation and proteid digestion, and hence is represented as a and x.

GRAPHIC REPRESENTATION

Of the Results of the Chemical Examination of Salivary and Gastric Digestion, Based upon the Study of over 5000 Cases in the Physiological Laboratory of the Battle Creek (Mich.) Sanitarium.

Case of..

ARRANGED BY
J. H. KELLOGG, M. D.

A′	H Free HCl.	C Combined Chlorine.	A Total Acidity.	S Starch Digestion.	COEFFICIENTS OF DIGESTIVE WORK. Chlorine Liberation. m	Fermentation. a	 x	Starch Digestion. b	Salivary Activity. c	Solution. y	Absorption. z
.430	.240	.410	.480	7.00	2.00	6.00	100	2.00	10.00	2.00	6.00
.410	.225	.390	.440	6.50	1.90	5.00	80	1.90	9.00	1.90	5.00
.390	.210	.370	.410	6.25	1.80	4.50	60	1.80	8.00	1.80	4.00
.370	.195	.350	.385	6.00	1.70	4.00	50	1.70	7.00	1.70	3.00
.350	.180	.330	.360	5.75	1.65	3.50	40	1.65	6.00	1.65	2.50
.335	.165	.315	.340	5.50	1.60	3.00	30	1.60	5.50	1.60	2.25
.320	.150	.300	.320	5.25	1.55	2.75	25	1.55	5.00	1.55	2.00
.305	.135	.285	.305	5.00	1.50	2.50	20	1.50	4.50	1.50	1.75
.290	.120	.270	.290	4.75	1.45	2.25	18	1.45	4.00	1.45	1.50
.275	.110	.255	.275	4.50	1.40	2.00	16	1.40	3.50	1.40	1.40
.260	.100	.240	.260	4.25	1.35	1.75	14	1.35	3.00	1.35	1.35
.245	.090	.225	.245	4.00	1.30	1.50	12	1.30	2.50	1.30	1.30
.230	.080	.210	.230	3.75	1.25	1.40	10	1.25	2.00	1.25	1.25
.220	.070	.200	.220	3.50	1.20	1.30	8	1.20	1.75	1.20	1.20
.210	.060	.190	.210	3.25	1.15	1.20	6	1.15	1.50	1.15	1.15
.200	.050	.180	.200	3.00	1.10	1.10	4	1.10	1.25	1.10	1.10
.195	.044	.174	.195	2.75	1.05	1.05	2	1.05	1.10	1.05	1.05
.190	.038	.168	.190	2.50	1.00	1.00	00	1.00	1.00	1.00	1.00
.185	.031	.161	.185	2.25	.95	.95		.95	.90	.95	.95
.180	.025	.155	.180	2.00	.90	.90		.90	.80	.90	.90
.170	.024	.145	.170	1.80	.85	.85		.85	.70	.85	.85
.160	.023	.135	.160	1.60	.80	.80		.80	.60	.80	.80
.150	.022	.125	.150	1.40	.75	.75		.75	.50	.75	.75
.140	.021	.115	.140	1.20	.70	.70		.70	.40	.70	.70
.130	.020	.105	.130	1.00	.65	.65		.65	.30	.65	.65
.120	.018	.095	.120	.90	.60	.60		.60	.25	.60	.60
.110	.016	.085	.110	.80	.55	.55		.55	.20	.55	.55
.100	.014	.075	.100	.70	.50	.50		.50	.15	.50	.50
.085	.012	.065	.085	.60	.45	.45		.45	.12	.45	.45
.070	.010	.055	.070	.50	.40	.40		.40	.10	.40	.40
.055	.008	.045	.055	.40	.35	.35		.35	.08	.35	.35
.040	.006	.035	.040	.30	.30	.30		.30	.06	.30	.30
.025	.004	.025	.025	.20	.20	.20		.20	.04	.20	.20
.010	.002	.010	.010	.10	.10	.10		.10	.02	.10	.10
.000	.000	.000	.000	.00	.00	.00		.00	.00	.00	.00
					m	a		b	c	y	z

HYPERPEPSIA
NORMAL
HYPOPEPSIA
APEPSIA
Imperfect Digestion of Albumen.
WELL DISINTEGRATED.
IMPERFECTLY DISINTEGRATED.
RAPID ABSORPTION.
SLOW ABSORPTION.

,The figures in each of the above columns relate to a particular quantity or quality of stomach work. The point at which the line starts indicates the class to which the case belongs, and the degree of hyperpepsia or hypopepsia, as the case may be, if the figures fall outside the normal limits.

The figures found in columns headed **A′, H, C, A,** and *a* relate to the digestion of albuminoids, or proteid substances.

The column headed **S** relates to the salivary digestion of starch, the figures having reference to the quantity of sugar (maltose expressed as milligrams of dextrose) found present in the stomach fluid.

Coefficients.—The columns headed *a*, *b*, *c*, *x*, *y*, and *z* relate to the coefficients of the several kinds of work done by the stomach.

Column **a** relates to proteid digestion and fermentation. The figures below the normal line in this column represent varying degrees of deterioration in the quality of the products of proteid digestion. The figures above the line to the left roughly indicate the degree of acid fermentation. Both conditions may exist together.

Coefficient **b** relates to the digestion of starch. The figures in this column represent the relation between the amount of maltose, or completely digested starch, found in the stomach fluid, and the total amount of sugar, soluble starch, and dextrine found present in the same case. The coefficient is determined by dividing the number of milligrams of maltose found in each 100 c.c. of stomach fluid by the total quantity of maltose, dextrine, and soluble starch found in solution. 1.00 of course represents the conversion of 80 per cent of the starch in solution.

Coefficient **c** represents the degree of secretory activity of the salivary glands and of the starch-converting power of the saliva. Normally, 10 to 12 c.c. of saliva are produced in five minutes, 1 c.c. of which is capable of completely converting .100 grams of starch in five minutes. Taking 10 as the normal quantity and 5 as the normal time, the coefficient of salivary activity is obtained by the following formula, in which Q represents the quantity secreted and T the time required for conversion: $\frac{5}{T} \times \frac{Q}{10} = c$ (coefficient of salivary activity).

Coefficient **x** represents the degree of fermentation present, as indicated by the number of milligrams of fatty acids per 100 c.c. of stomach fluid.

Coefficient **y** represents the total work of disintegration and solution performed by the mouth and the stomach. The figures representing this coefficient are obtained by dividing the amount of residue obtained by filtration of the stomach fluid, by the total amount of stomach fluid obtained. In normal cases the residue equals one half the total amount. The coefficient is found by the following formula, in which A represents the amount of stomach fluid and R the residue:

$$\frac{A}{2R} = y, = 1.00 \text{ (in normal cases)}$$

Coefficient **z** represents the work of the stomach in the absorption of fluids. This coefficient is obtained by dividing the normal quantity of stomach fluid which should be obtained viz., 40 c.c., by the quantity actually obtained.

Coefficient **m** indicates the relative amount of chlorin liberated in the form of free hydrochloric acid.

Results of Qualitative and Quantitative Determinations Relating to Salivary Digestion and the Stomach Fluid Obtained after a Test Meal.

No..........

Mr.. **Date,**.........189..

Test Meal.—Regular Breakfast, after Lavage..............................
Time of Digestion:......h......m...................

PHYSICAL AND MICROSCOPICAL CHARACTERS.

Physical.
Amount.....c.c. (40 c.c. Normal. 1⅓ oz.); Disintegration.....; Color.....
Residue.........grms. (20 grms.); Mucus.........; Odor........

Microscopical.—Blood..........; Pus..........; Misc...........

Bacteriological.—No. of microbes per c.c. (30 c.c. = 1 oz.)..........
General Characteristics..
Yeast.............................. Mold..........................
Acid formation.........Gas production.........Liquefying..........

COLORIMETRIC AND OTHER QUALITATIVE REACTIONS.

DIGESTIVE AGENTS.

Free HCl Congo Red........Resorcine........Dried Residue........
Pepsin.... Rennet Ferment.... Rennet Zymogen.... Bile....

DIGESTIVE PRODUCTS.

Proteids.—Syntonine....Propeptone.... Peptone....Albuminoids....

Starch (Lugol's Sol.), Blue, Violet, Brown, Yellow, Colorless.

FERMENTATION PRODUCTS.

Lactic Acid..........
Alcohol.............. Volatile Acids........... { Acetic..........., Butyric.........., Formic..........
Misc...............

QUANTITATIVE CHEMICAL DETERMINATIONS.

DIGESTION OF ALBUMEN.

		Normal quantities.*	
Total acidity, (A)....................	grms.	(.180-.200 grms.)	A′
Calculated acidity, (A′)**............	"	" "	A′
Total chlorine, (T)..................	"	(.300-.330 ")	
Free HCl, (H).......................	"	(.025-.050 ")	H
Combined chlorine, (C)...............	"	(.155-.180 ")	C
Fixed chlorides, (F).................	"	(.100-.110 ")	$\frac{T-F}{T}$ = .66

DIGESTION OF STARCH.

Saliva, Reaction { Acid........ / Alkaline..... } am't in 5 m......grms. 1 c.c. converted .1 grms. in......m.

Maltose, (M)..grms.
Dextrine and Soluble Starch (D)...............................
Fatty Acids (from fermentation) (L).........................
(Lactic acid......grms. Volatile Acids......grms.)

COEFFICIENTS OF DIGESTIVE WORK.††

Gastric Digest'n { **Proteids** (*a*)............... **Fermentat'n** (*x*)..
{ **Starch** (*b*)................. **Solution** (*y*)......
Salivary Activity (*c*).............. **Absorption** (*z*)...
Relation of HCl set free to Total Chlorine (*m*)..............
Proteid Digestion and Acid Fermentation (*a* and *x*)..........

Diagnosis.—Classification....................
Remarks:...
Prescription:...
....
....

* The acidity (A and A′) and the quantities of chlorine in the different forms of (T), (H), (C), and (F), are expressed as HCl. The values given relate to 100 c.c. of stomach fluid. The amount of fatty acids, chiefly lactic (L), is expressed in grams of HCl, which should be multiplied by 2 to indicate the actual amount of lactic acid present. The amount of maltose (M) as well as that of soluble starch and dextrine (D) is expressed in grams of equivalent dextrose.

†By noting the sign following the symbols in this column and coefficients (*a*) and (*x*), and referring to the classification, the diagnosis of any case in relation to proteid digestion and fermentation may be easily made. By transferring the figures to the blank for "Graphic Representation," the indications will be seen at once, the analysis thus furnishing a basis for rational treatment and the proper dietary.

** The calculated acidity (A′) is determined by the following formula: C + H — L = A′.

†† The normal amount of work is, in the case of each coefficient, represented by 1.00. The figures given usually represent the percentage of deviation from normal. The coefficient of fermentation represents the number of milligrams of lactic acid or combined fatty acids found in each 100 c.c. of stomach fluid (expressed in equivalent HCl).

The sign + indicates presence in normal quantity; ++ in excessive quantity; — in deficient quantity; o (zero) wholly absent.

change in the work done by the stomach is normal, the change in the stomach work being qualitative rather than quantitative. By these studies I have been enabled to subdivide these several classes as follows : —

Hyperpepsia, into three principal classes, and twelve subclasses.

Hypopepsia, into two principal classes and eight subclasses.

Apepsia, into two subclasses.

Simple dyspepsia, into four subclasses.

This makes twenty-six different varieties of indigestion, each with its individual characteristics. The study of over fifty-three hundred analyses made with painstaking accuracy accords with the methods which I have very briefly described. I have not found a single case which did not fall in one of the classes named, and have found examples of every class, although some of the classes have been represented by but a very few cases. I conclude from this fact that this classification is complete.

I will not here enter into the details of classification, as this is shown in the blank referred to, which also sets forth the particulars of the method for obtaining the several coefficients. The technique of the chemical methods employed I have given in other papers ; my present purpose is simply to exhibit the fact that the method of investigation is not hypothetical nor uncertain, but has a definite and scientific foundation. One feature of the method of investigation pursued is to such an extent new, and develops facts so interesting, that I may be pardoned for presenting it at length. The feature referred to has relation to the digestion of starch in the stomach.

THE STOMACH DIGESTION OF STARCH.

The subject of the stomach digestion of starch is one which seems to have been almost wholly neglected until very recently ; and even yet the majority of our text-books on physiology teach that the digestion of starch in the stomach is a matter of little or no consequence, the supposition being that the activity of the saliva ceases very soon after the food enters the stomach, in consequence of the inhibitory action of the gastric juice. Within a few years, however, the fact has been established that the active principle of the gastric juice converts starch into maltose, not only in a slightly alkaline medium, but also in the neutral or even slightly acid medium; and that, in fact, the digestion of starch proceeds more actively in a neutral medium than in one which is alkaline. Hence the alkalinity of the saliva appears to have for its purpose, not the direct increase of the activity of the ptyalin, but the prolonging of its action after it enters the stomach by the neutralization of the acidity of the gastric juice. Thus the saliva is enabled to act in the stomach with even greater rapidity than in the mouth, and may continue this action for half an hour or more after the food has been swallowed. This is amply sufficient time to enable the saliva, if a sufficient quantity of it is mixed with the food, to convert into maltose a large portion of the farinaceous constituents of the food, provided the food has been sufficiently well divided to present a surface large enough to bring the saliva promptly into contact with every particle of the digesting mass.

I have studied the salivary digestion of starch by two methods: —

1. By the establishment of a coefficient of salivary activity. This is done by a comparison of the quantity and quality of the saliva with the normal standard. The quality of the saliva is determined by the method of diastasimetry devised by Sir Wm. Roberts, an English physiologist, some years ago. The saliva is obtained by making the patient chew a quantity of paraffin gum for five minutes.

2. By the determination of the relative amounts of maltose, dextrin, and soluble starch found in the stomach fluid. The coefficient of starch digestion in the stomach is based upon a comparison of the amount of maltose with the amount of dextrin and soluble starch. The saliva acting upon the starch in a test-tube is capable of converting eighty per cent of it into maltose. Probably a larger per cent than this is converted in the stomach on account of the absorption of the maltose as formed, but I have thought it best to take eighty per cent as the standard for comparison; that is, to require that the stomach fluid, to be normal, shall show but twenty per cent of dextrin and soluble starch to eighty per cent of maltose.

I have been surprised at the large amount of maltose found present in the stomach fluid. In an examination of 965 stomach fluids by this method, I have found an average of 2.3 grams of maltose per 100 c. c. of stomach fluid, or 2.3 per cent of maltose. The average amount of maltose, dextrin, and soluble starch combined, representing the total digestive work of the saliva, is nearly four grams, or four per cent. In some instances I have found as much as seven grams, or seven per cent.

An interesting fact which I have constantly noted is the much higher percentage of maltose in cases of hypopepsia as compared with hyperpepsia; for example, the average proportion of maltose in hyperpepsia is 1.9 grams per 100 c. c. of stomach fluid, and in hypopepsia 2.6, or 35 per cent more than in hyperpepsia. The average coefficient of salivary activity is precisely the same in hyperpepsia and hypopepsia, showing clearly that the difference must be due to the difference in the acidity of the stomach contents. The average per cent of maltose in twenty cases of pronounced hyperpepsia was 1.8, and the coefficient .60. In eighteen cases of pronounced hypopepsia or apepsia, the per cent of maltose was 3.7 and the coefficient .89. In other records the total amount of maltose in hypopepsia was more than double that in hyperpepsia, and the ratio of complete conversion was fifty per cent greater. So much for the methods employed.

EXPERIMENTAL RESEARCHES RELATING TO STARCH DIGESTION IN THE STOMACH.

	Water biscuit, well chewed. 1	Water biscuit, not chewed. 2	Raw flour. 3	Raw wheat. 4
Total acidity (A)	.142	.140	.204	.136
Calculated acidity (A′)	.156	.132	.186	.128
Total chlorin (T)	.296	.284	.332	.272
Free HCl (H)	.050	.028	.056	.052
Combined chlorin (C)	.106	.104	.130	.076
Fixed chlorids (F)	.114	.152	.146	.144
Maltose (M)	1.088	.272	.000	.000
Dextrin and soluble starch (D)	.812	.548	.300	.448
COEFFICIENTS.				
Digestion of albumen (*a*)	.82	.97	1.00	1.00
Digestion of starch (*b*)	.71	.42	.00	.00
Salivary activity (*c*)	1 17	1.11	1.14	1.37
Fermentation (*x*)	5	11	6	6
Chlorin liberation (*m*)	.80	.70	.85	.71

I will now call attention to the results of some experiments which I have made.[1] Selecting several healthy young men, by an extended series of experiments I undertook to determine some facts in relation to the hygiene of starch digestion. The above table represents the results obtained in a comparison of stomach fluids obtained after (1) water biscuit well chewed; (2) water biscuit broken, moistened with water and swallowed without chewing; (3) raw flour; (4) raw wheat, the meal consisting of one and one-half ounces of solid substance mixed with eight ounces of water in each case.

Several points of interest are to be noted in the foregoing table, the first and most conspicuous of which is the fact that the saliva did not act at all upon the raw flour and raw wheat, as shown by the total absence of maltose in the cases represented in columns 3 and 4. The small amount of dextrin and soluble starch shown was perhaps already present in the raw grain, but this point I have not investigated. It is clear, however, that no sugar was produced when raw starch was taken, whereas the amount of sugar produced after the ordinary test meal was more than 1 gram in each 100 c.c. of stomach fluid; in other words, the stomach fluid contained more than one per cent of sugar without taking into account the amount which had been absorbed.

The figures for maltose in column 2 represent a test meal in which little or no saliva was mixed with the food substance, it being swallowed without chewing. Thus it indicates very slight action of the saliva, the amount of maltose found in the stomach fluid being but a trifle more than one fourth the amount obtained after an ordinary test meal. The amount of soluble starch and dextrin was less than half the normal amount in the case of the raw flour, and but little more in the case of the raw wheat.

Another point of interest is the increased amount of lactic acid found in the test meal taken without chewing, represented in column 2. The coefficient of fermentation which represents the number of milligrams of lactic acid (expressed in terms of HCl) found in 100 c.c. of stomach fluid, was more than double

[1] A considerable portion of the following facts have been presented in another paper entitled, "Experimental Research Relating to Salivary Secretion and Digestion."

that found after the same kind of test breakfast properly masticated, represented in column 1. The results of this experiment distinctly associate fermentation with imperfect mastication and imperfect salivary digestion.

Another fact noted in a comparative study of the results of the analyses of over five thousand stomach fluids, which very strongly confirms this idea, is that starch conversion is usually complete in cases of apepsia, while lactic acid is conspicuous by its absence. In nearly all cases of apepsia which I have encountered, numbering about forty in all, the most delicate tests for lactic acid have failed to show its presence except in the most minute quantities; in most cases it was entirely absent.

Another fact of perhaps even greater interest has relation to the digestion of albumen when the wheat was eaten raw, in the form of either flour or wheat. The coefficient of proteid digestion in both cases, as is shown in columns 3 and 4, was 1.00, indicating perfect elaboration of the albuminoids. From this it appears that raw gluten, or the proteids of wheat, is digested more perfectly when taken in a raw state than when cooked, the very opposite of which we have seen to be true of starch.

The digestion of raw starch may take place in the intestines, by the action of the pancreatic juice, but cannot take place in the stomach, for the reason that the saliva has not the power to penetrate the cellulose envelope of the starch granule, and hence cannot digest raw starch. This fact coincides in a most interesting manner with the biological fact that man is by nature a frugivorous animal. In the process of ripening, the starch of fruits undergoes a hydration similar to that which takes place in cooking and in pancreatic digestion, whereby the insoluble starch is converted into soluble starch, dextrin, and sugar. This explains, also, why well-ripened fruit may be eaten raw with impunity, while unripe and farinaceous foods of all kinds require cooking. In his diet, man, like his nearest relative, the monkey, being naturally a frugivorous animal, may eat fruits in the state in which nature has provided them; but when he introduces other natural products into his bill of fare, he must adopt artificial means for securing the preparation for digestion which nature makes in the ripening process of fruits.

The coefficient of chlorin liberation (*m*) is very nearly uniform, indicating that the mastication and the cooking of food have little influence upon this digestive function.

The coefficient of salivary activity (*c*) was determined independently for each test breakfast. Its practical uniformity indicates that there was no essential change in the character or quality of the saliva to account for the differences shown by the totals in relation to the stomach digestion of starch.

THE INFLUENCE OF MOIST AND DRY FOOD UPON SALIVARY SECRETION.

A series of experiments made to determine the influence of moist and dry food, natural food-flavors, and condiments or unnatural food-flavors upon salivary digestion, developed very striking and unexpected results, which I quote from another paper in which the outcome of these researches is presented in greater detail :—

The quantity of food or fluid was, in each case, thirty grams. The food, whether solid or fluid, was taken into the mouth in small portions and chewed for a few seconds, when, being rejected from the mouth, it was received into a small vessel for weighing. The length of the experiment with each substance lasted exactly five minutes. The difference in weight between the substance after chewing and before, represented the amount of saliva which had been added to it during mastication. I may add that the solid food used was granose, a dry and well-cooked preparation of wheat in thin flakes.

Thirty grams, or one ounce, of granose increased in weight 59.79 grams, or two ounces.

Thirty grams, or one ounce, of granose, with two grams of common salt, increased in weight 58.80 grams, or a little less than two ounces.

Thirty grams, or one ounce, of granose sprinkled with pepper increased in weight 59.1 grams, or not quite two ounces.

Thirty grams, or one ounce, of granose, with 5 c.c. of strong cider vinegar, increased in weight 55.9 grams, or about one and five-sixths ounces.

Thirty grams, or one ounce, of moist bread increased in weight 31.1 grams, or one ounce.

Thirty grams, or one ounce, of raw apple increased in weight 38.1 grams, or one and one-fourth ounces.

Thirty grams, or one ounce, of water increased in weight 2.92 grams, or one tenth of an ounce.

Thirty grams, or one ounce, of milk increased in weight 2.82 grams, or one-eighth ounce.

Thirty grams, or one ounce, of pea soup increased in weight 5 82 grams, or one-fifth ounce.

Paraffin chewed for five minutes produced 20 c. c. of saliva, or two thirds of an ounce.

The facts developed by the above-mentioned experiments furnish the foundation for most important therapeutic rules for the management of digestive disorders. It will be noted, on the one hand, that one ounce of dry granose chewed for five minutes so stimulated the activity of the salivary glands as to enable them to produce almost exactly two ounces of saliva, or three times the amount normally secreted by the young man who was made the subject of the experiment; on the other hand, the amount of saliva secreted when water was passed through the mouth amounted to a little less than 3 c. c. in five minutes, or about one seventh of the normal amount. With dry granose the amount of saliva secreted was *more than twenty times as great as with water.*

With moist bread the amount of saliva secreted was almost exactly half that with dry granose.

With milk the amount of saliva produced was only about one third more than that produced with pure water.

With pea soup the quantity was just twice as great as with water, but the amount was still only one tenth the amount produced with dry granose.

This fact places before us in the most graphic and emphatic manner the necessity for the use of dry food in cases of salivary indigestion. Instead of feeding our patients with malt, pancreatin, diastase, and predigested foods, we have only to require them to chew dry food; and in so doing they will develop in abundant quantity a starch-digesting ferment of greater value, because better adapted to the human stomach, than any possible artificial digestive agent which could be administered.

The use of "slops" is one of the most common dietetic errors among the American people. The American eats in a hurry, rinses down his food with copious draughts of tea, coffee, iced water, iced milk, or iced tea, and in consequence the salivary glands are not stimulated to proper activity, and so the amount of saliva produced is altogether inadequate to digest the starchy elements of food in the acid medium of the stomach contents, and the small amount produced is so diluted that its efficiency is greatly impaired. What wonder that starch indigestion is coming to be an almost universal complaint, as shown by acidity, eructations of gas, flatulence, and a great variety of stomach disturbances, to escape from which multitudes are continually swallowing quantities of magnesia, soda, neutralizing cordials, and alkaline mineral waters of various sorts, together with malt extracts and other digestants?

The inability to digest starch is doubtless one of the great causes of the inordinate consumption of beef and other animal products to which the average American has come to be addicted, not altogether in imitation of his English cousin, but as a method of escaping the pangs of starch indigestion.

The abundant provision made in the human body for the digestion of starch,—first, the saliva; second, the bile and pancreatic juice; third, the intestinal juice; and finally, the liver, —is evidence that nature intended man to subsist largely upon farinaceous foods. The arguments of the "natural food" advocates, who insist that man should live upon fruits and nuts, are based, not upon physiological facts, but upon the pathological experiences of the disciples of this doctrine. The writer having an opportunity, a year or two ago, to examine the stomach fluid of one of the most earnest and stalwart advocates of the fruit-and-nut diet, found the stomach greatly dilated, and almost completely inert.

I have cured many scores of chronic and very obstinate cases of dyspepsia by simply requiring the patient to subsist upon a dry diet, whereby he was compelled to thoroughly masticate his food. A favorite prescription with the writer, which is applicable to most cases of indigestion, is two or three ounces of dry granose at the beginning of each meal. This introduces into the stomach an abundant quantity of saliva,

—probably from four to six ounces in most cases,—and insures efficient starch digestion in cases of both hypopepsia and hyperpepsia. It also serves to mitigate the acidity of hyperpepsia, and operates to prevent fermentation by the rapid solution and conversion of the farinaceous elements, thereby promoting their absorption. I am inclined also to the opinion that the maltose produced by the salivary secretion exercises in some way a controlling and beneficial influence on the processes of stomach digestion. The density of the stomach contents must have something to do with the chemical changes which occur during digestion. The presence of maltose in proper quantity may be the means of aiding glandular activity and absorption.

This is a subject which I am endeavoring to investigate, and upon which I hope to be able to throw some light by further experiments.

At a recent meeting of the American Medical Association, in a discussion which occurred upon a paper read by the writer, in which vinegar had been condemned on account of its powerful inhibitory influence upon salivary digestion, one of the speakers suggested that the stimulating effect of vinegar upon the salivary glands, thereby promoting the secretion of saliva, might more than counterbalance the inhibitory influence of this condiment, —in other words, the extra amount of saliva produced by the vinegar might more than balance the lessened activity of the secretion resulting from the presence of this acid. The same thought was expressed in reference to salt, pepper, and other condiments. I consequently subjected this matter to experiment, with the results already stated in this article. The amount of saliva secreted when salt, pepper, or vinegar was added to the granose, was in each case less than when the granose was taken by itself. In the case of vinegar the deficiency was much greater than with the other condiments.

We see from this that dryness is the property in food which stimulates the salivary glands to activity. A perfectly dry food excites the maximum amount of activity. The degree of stimulation produced by a dry food, such as granose, is indeed surprising, the amount of saliva secreted during the five minutes required for the mastication of the somewhat bulky granose (the young man masticated the food as rapidly as possible, ejecting it from the mouth as soon as it became well moistened) being twice the weight of the granose itself. The slightly lessened stimulating effect observed when pepper was added was probably accidental, as the figures agree as nearly as three experiments with granose alone would be likely to agree. However, the amount with vinegar is perceptibly less, showing that nature does not propose to waste energy in secreting saliva to be spoiled ; in other words, a substance which destroys the activity of the fluids produced, is not capable, apparently, of promoting the activity of the salivary glands in the secretion of saliva. I do not undertake to lay this down as a general principle, but it seems to hold good in relation to vinegar at least. I have planned an extension of this experiment as a side-line of this interesting inquiry.

Another experiment of interest in the same connection was made for the purpose of determining the relative value of natural flavors ; that is, such flavors as are found in natural and wholesome foods, in stimulating the secretion of saliva.

The mastication of an ounce of apple within five minutes produced 34 c.c. of saliva, 3 c.c. more than was produced in the mastication of moist bread. The proportion of water in the apple was certainly not less than that in the moist bread, nevertheless a larger amount of saliva was secreted, resulting doubtless from the stimulating effect of the natural flavors of the apple.

I have not space in this paper to go further into the practical deductions which may be drawn from these experiments. The subject is a comparatively new one, as almost no experimental work has been directed toward it, probably in consequence of the generally received assumption that the activity of the saliva upon the food ceases as soon as it enters the stomach. More recently developed physiological facts in relation to salivary digestion, which are very clearly stated by Freirichs, Ewald, Gamgee, and other excellent authorities, must lead to a revolution, not only in relation to our way of looking at stomach digestion, but also in relation to the therapeutics and dietetics of a large class of digestive disorders.

The extensive use of malt preparations of various kinds and the benefit recognized by many physicians, arising from the employment of diastatic ferments, substantiate the statement previously made in this paper that the inability to digest starch is one of the most common conditions existing among dyspeptics. In the examination of more than fifty-three hundred stomach fluids, I have found that the conversion of starch was complete in less than three hundred cases, and in quite a large number of cases there has been chemical evidence of little or no conversion. It is evidently, then, a matter of importance to know what substances, if any, interfere with starch digestion. The following is a brief resumé of the observations which I have made upon this point: —

EXPERIMENTS RELATING TO SUBSTANCES WHICH IMPEDE STARCH DIGESTION.

	Time.
Oxalic acid:	
1–10,000	No action.
1–15,000	35 minutes.
1–20,000	19 "
1–30,000	4 "
Lemon juice:	
1–200	No action.
1–500	42 minutes.
1–2,000	9 "
1–5,000	7 "
Orange juice:	
1–200	11 minutes.
1–500	4 "
Apple juice:	
1–50	45 "
1–200	4 "
Vinegar:	
1–200	No action.
1–500	40 minutes.

Experiments were also made for the purpose of determining comparatively the influence of the same substances upon the action of malt diastase upon starch. The preparation of diastase used was a malt extract, one c.c. of which was capable of completely converting one-tenth gram of starch in two minutes. The following were the results: —

	Time.
Oxalic acid:	
1–2,000	No action.
1–5,000	5 minutes.
1–10,000	2 "
Lemon juice:	
1–10	No action.
1–200	2 minutes.
Apple juice:	
1–10	2 minutes.
Vinegar:	
1–10	10 minutes.
1–200	2 "
Hydrochloric acid:	
1–4,000	No action.
Lactic acid:	
1–200	No action.
1–2,000	5 minutes.

Several points of interest may be deduced from these experiments. A few may be briefly mentioned: —

1. Acids of all kinds inhibit the diastatic action of both saliva and malt, but human saliva is very much more susceptible to the inhibitory action of acids than is malt.

We find here an explanation for the observation previously made by patients, that sour fruits disagree with them; but to test the matter further, I administered a number of experimental breakfasts in which vinegar and other acids were added to the stomach fluid. When one-half ounce of vinegar was added to the meal, it was found that the coefficient of starch digestion was reduced to .64. With the juice of one lemon, the coefficient was reduced to .29.

These experiments show very clearly that vegetable acids as well as the acids of the gastric juice have a decidedly deterrent effect upon starch digestion, and hence that they must be withheld in cases in which the digestion of starch is performed imperfectly or with difficulty. It is also apparent from the observations previously made that it is in cases of hyperpepsia especially that acids must be withheld, since in hyperpepsia starch digestion is already more or less interfered with by an excessively acid gastric juice.

The observations of Roberts, as well as my own, show that tea and coffee inhibit the action of the saliva upon starch to a very remarkable extent. Brinton, Wolff, Debove, and Reymond all assert that caffein diminishes the activity of the peptic glands, which accounts for the deleterious effect of tea and coffee upon digestion.

Gerard has shown that chloride of sodium, when taken in excessive quantities, interferes with gastric digestion by provoking a profuse secretion of mucus, whereby the gastric juice is neutralized and its action upon the food impeded.

PEPTOGENS VERSUS DIGESTIVE FERMENTS.

With reference to substances supposed to aid digestion, it is surprising that so small an amount of attention has been given experimentally to the influence of pepsin upon digestion, when the enormous quantities of this and other digestive agents used are taken into consideration.

Some years ago Mosso, by experiments upon a dog, determined that the stomach of a dog of ordinary size was able to furnish pepsin enough to digest seventy kilograms, or 165 pounds, of albumen. This fact was ascertained by passing through the dog's stomach 2000 litres of water, acidulating the same with hydrochloric acid, and determining its degree of digestive activity.

More recently, Georges has demonstrated that the use of pepsin is absolutely valueless in cases of insufficiency of the gastric glands. The wines of pepsin, papaine, and pancreatin, either with or without hydrochloric acid, are, according to Debove and Reymond, valueless to supply a deficiency of pepsin formed by the glands in the stomach. My own observations agree exactly with those of the authorities mentioned, in this respect.

After having employed pepsin for many years, on the strength of authority, I have for some time past abandoned its use altogether, along with other digestive ferments, with the exception of malt, having been utterly unable to see any good results whatever from its use. What the stomach requires in cases of inactivity of the gastric glands, is, not a substitute for the normal product of these glands, but an increase of the activity of the glands. Peptogens are needed rather than peptones, peptonoids, or pepsins. Proteid substances are the best of all peptogens. The natural flavors of foods and the dextrin developed by the action of the saliva upon starch are also peptogens of the highest value. The fact last mentioned furnishes another plea for the use of dry foods by dyspeptics, thus securing thorough mastication.

In an experiment which I made to determine this point, it was found that the quantity of hydrochloric acid present in the stomach fluid after a well-masticated meal, consisting of water biscuit and water, was nearly double (or an increase from .028 to .05 milligrams per 100 c.c. of stomach fluid) that obtained after a test meal which was not masticated, from which it appears that thorough mastication encourages the production of HCl, as well as pepsin.

One of the very best of all peptogens is gluten. Eggs and milk are also peptogenic substances of value, particularly eggs.

The peptogenic power of gluten is well shown in the following cases:—

After an ordinary test meal the amount of free HCl was found to be .046 per 100 c. c. of stomach fluid; the amount of combined chlorin, .232. In a test meal consisting of one ounce of water crackers eaten dry, and one ounce of gluten mixed with water and swallowed directly afterward, the amount of HCl was found to be .064 per 100 c. c., and combined chlorin, .284, or an increase of forty per cent. In another instance the amount of free HCl was increased from .036 to .130, or 266 per cent, and the total acidity was increased from .260 to .354.

In a second meal, consisting of one ounce of pure gluten well chewed, dry, and eight ounces of water swallowed afterward, the total acidity was increased from .260 to .398, the combined chlorim from .216 to .294, and the free HCl from .036 to .046. No better evidence of the peptogenic properties of gluten could be asked for.

The popular idea that pepper, mustard, and similar substances increase digestive vigor has been shown by experiments to be erroneous. These substances, like common salt in excess, increase the flow of mucus without increasing the production of pepsin or hydrochloric acid. The production of pepsin and hydrochloric acid can be increased only by natural stimuli; that is, the peptogenic substances which nature puts into our food. These consist: (1) Of proteid substances which are intended to be digested by the action of pepsin and hydrochloric acid; (2) Of dextrin, the substance which naturally precedes peptone in the order of production in the digestive process; and, (3) Of food-flavors which by their reflex action increase the activity of all the digestive glands, as a preparation for the digestive act.

The secretion produced by mustard, pepper, pepper-sauce, and similar substances is for protective purposes only, the stomach pouring out a quantity of mucus which is spread over the mucous surface to protect it from the action of these abnormal and irritating substances. Alcohol, which has been supposed to be so beneficial to digestion, my experiments show to be equally destructive and injurious. This is well shown by the following experiments: —

The subject was a young man aged nineteen years. The analysis of stomach fluid, with the usual test breakfast and without brandy, gave the figures shown in the following comparative table, which relate to the number of milligrams of chlorin expressed in HCl found in 100 c.c. of filtered stomach liquid:—

	Usual Test Breakfast.	Usual Test Breakfast with 4 oz. of Claret.	Usual Test Breakfast with 2 oz. of Brandy.
	grms.	grms.	grms.
Total acidity	.240	.086	.016
Total chlorin	.328	.216	.306
Free HCl	.032	.000	.000
Combined chlorin	.268	.120	.034
Fixed chlorin	.098	.116	.172
Coefficient	.77	.72	.47

Peptones and propeptones were found to be notably diminished in proportion to syntonin in the stomach fluid containing brandy.

These experiments were repeated upon different persons, and with alcohol in different forms, as gin, brandy, wine, etc., the quantities being made such that the same amount of alcohol, about one ounce, should be taken in each case; and the results were found to be practically uniform, and essentially the same as have been given above. The accompanying comparative table shows very clearly the great diminution in the chemical activity of the stomach produced by alcohol. By a careful study of the table, it will be noticed that the young man who was the subject of the experiment had a more than normally active digestion. There is no excess of free hydrochloric acid, but an unusually large amount of combined chlorin, indicating what might be considered a physiological hyperpepsia, since the quality of the work done was but slightly below the normal standard, as shown by the value of the coefficient *α*. Four ounces of claret caused the complete disappearance of the free HCl, diminished the combined chlorin more than fifty per cent, and also diminished the quality of the digestive work done. The test made with the two ounces of brandy shows almost a complete paralyzing of the stomach, or apepsia. The free HCl disappeared entirely; and the combined chlorin, representing the useful stomach work, was reduced to .034, or one eighth the amount done under normal conditions. This influence upon the digestion is exactly what would be expected of a drug like alcohol, which is a paralyzer of protoplasmic activity, an anesthetic, and a sedative — and not a stimulant, as has been erroneously supposed. It should be added that each preparation of alcohol was diluted with water, so as to make exactly eight ounces of fluid in each case.

STUDY OF THE GERMS OF THE STOMACH.

Still another question of interest which I have made the subject of experimentation is the relation of food to fermentation. My experiments in this line are yet (December, 1895) incomplete, but one or two facts of interest may be noted. The relation of a coated tongue to indigestion, especially that form frequently termed "biliousness," is universally recognized. It is equally well known that the appearance of the tongue when coated is due to a growth of micro-organisms. The tongue is coated, not out of sympathy with the stomach, as was formerly supposed, but in consequence of the development upon it to an abnormal extent of micro-organisms in connection with a similar abnormal development of micro-organisms in the stomach. A bad taste in the mouth is due to the development of ptomains which are not only disagreeable in flavor, but toxic in character. The absorption of these ptomains from the stomach gives rise to headache, vertigo, mental confusion, and the great variety of other symptoms of which bilious persons complain.

Studies which I have made with reference to the relation of conditions of the stomach to urinary toxicity, lead me to believe that many symptoms which are attributed to morbid states of the nervous system, are really due to autointoxication growing out of morbid conditions in the stomach, which are, to some degree, at least, indicated by a low coefficient of albumen digestion. A low coefficient indicates not only imperfect digestion of albumen, but the production of a proportionately large quantity of vitiated albuminoid substances which are worthless for nutrition, and which appear to possess toxic properties, giving rise to languor, drowsiness, headache, nervousness, and possibly also to neuralgia, rheumatic pains, and other symptoms commonly recognized as belonging to the arthritic diatheses.

Within the last few months we have undertaken in the Laboratory of Hygiene connected with the Battle Creek Sanitarium, under the supervision of Professor Novy, of the University of Michigan, an extensive investigation of the microbic life of the stomach, for the purpose of determining, if possible, what relation there may be between microbes in general or any specific microbe or group of microbes and the various pathological conditions of the stomach, particularly in such functional disorders as biliousness, migraine, catarrh of the stomach, etc. Dr. Turck, of Chicago, has been for some years engaged in this line of investigation, and has developed some most interesting and important results. I am giving particular attention to the study of the subject in connection with the peculiar idiosyncrasies which patients frequently present in reference to such articles of food as milk, fats, meat, starch, etc.

An interesting fact was developed at the beginning of this investigation which I wish especially to mention, as it emphasizes most decidedly one point relating to the hygiene of digestion and the therapeutics of indigestion. The first step in the investigation was to become familiar with the microbes which are normally found present in the stomach. Several healthy young men were accordingly selected, and test breakfasts, each consisting of one and one-half ounces of granose, a thoroughly sterilized preparation made from entire wheat, mixed with eight ounces of water, were administered. From nine stomach fluids obtained after this meal, only two cultures were obtained, seven of the stomach fluids having been found perfectly sterile. In the two instances in which microbes were found, they were very few in number. The test meal was then changed, and water biscuit, consisting of flour and water baked in small cakes, were substituted for granose. Germs in great abundance, with yeast germs of various sorts, at once appeared. Ordinary fermented bread and similar foods likewise gave plenty of microbes in nearly every case.

Since the above observation was made, careful bacteriological examination has revealed the total absence of germs in more than twenty additional cases. In fact, it may be said to be demonstrated that with sterilized food, no germs are to be found in the stomach at the end of an hour after eating.

This experiment shows very clearly, not only that the stomach is capable of destroying the microbes which are incidentally introduced along with the meal, provided the food is thoroughly sterilized (at least in the case of a cereal food), but that the stomach does ordinarily do this, and hence that the action of microbes in the stomach is not essential to the normal processes of digestion.

The chemical investigations made after the test meal are likewise in accordance with these results. In a case in which the coefficient of fermentation was found to be three, after a meal consisting of granose and water, the coefficient was found to be ten after a test meal of baker's bread and water.

The reason for these results was evidently due to the presence of yeast germs in the bread, as the material was the same,—wheat in each case. Granose consists of very thin flakes which have been very thoroughly cooked by both moist and dry heat; water biscuit consist of ordinary flour baked in cakes half an inch thick, so that the interior of the cake is not exposed to a sufficiently high degree of heat to thoroughly sterilize it. The center of a loaf of ordinary baker's bread likewise does not reach a sufficiently high temperature during baking to destroy the microbes which are always present, being contributed by the yeast and flour, as well as by the water used in making the bread.

Recent studies which I have undertaken for the purpose of determining the relation of such germ-infected foods as cheese, meat, unwashed fruit, etc., have given some very interesting results. For example, in the case of cheese, with which five experiments were made, the stomach fluid, though practically sterile, gave rise to more than 17,000,000 colonies for one ounce of stomach fluid. Scraped beefsteak, in the condition usually furnished for table use, gave 788,580 colonies. Unwashed fruit (grapes) gave 535,240 colonies. Fermented yeast bread gave rise to 45,300 colonies.

In a future paper I hope to be able to present many interesting facts upon this branch of the subject.

The technical portion of the bacteriological work done in connection with these studies has been done by Dr. Geo. W. Burleigh, bacteriologist of the Battle Creek (Mich.) Sanitarium, with the collaboration and assistance of Prof. F. G. Novy, M. D., professor of bacteriology in the University of Michigan, and a bacteriologist of large experience.

Out of many hundreds of experiments which have been carried out in the Sanitarium Laboratory of Hygiene. I have given only a few as illustrative of facts which may be gathered by this mode of study. The conclusions to which I have arrived as the result of their investigations thus far, may be briefly summarized as follows : —

1. The stomach digestion of starch is an important digestive function, and one which requires consideration in the treatment of dyspepsia.

2. The best means of promoting salivary digestion is the use of dry food and its thorough mastication.

3. The use of strong acids, even vegetable acids, is prejudicial to the digestion of starch in the stomach.

4. Thorough sterilization of food is important as a means of aiding the stomach in ridding itself of microbes.

5. The use of vinegar, condiments, tea, coffee, and alcohol is prejudicial to both salivary and gastric digestion.

6. Pepsin and other digestive agents, with the possible exception of the diastase of malt, are practically valueless as aids to digestion.

INFLUENCE OF MALT UPON STOMACH DIGESTION.

I have made a possible exception of malt in my statement respecting digestive ferments, for the reason that we find rare cases in which the saliva is so deficient in quality, even though abundant in quantity, that its digestive work must be very imperfectly performed. in such cases the use of malt in liberal quantities might prove beneficial. However, by comparison of the digestive activity of malt with that of saliva, by Roberts's method of diastasimetry, I have found that two parts of average saliva are equal in digestive vigor to one part of malt; hence all the good effects which may be obtained from malt, so far as its digestive qualities are concerned, may be obtained by a little extra mastication of food, thus securing a more liberal admixture of saliva.

I do not wish to be understood, however, as indicating that malt may not be otherwise beneficial. It is unquestionably an excellent food, and doubtless aids in some way in promoting the digestive process, either as a peptogen or as a regulator of the process of absorption.

A young man whose stomach fluid after a meal consisting of one ounce of gluten mixed with eight ounces of water and swallowed, gave the following figures: Total acidity, .248; free HCl, .076; combined chlorin, .184, furnished after a meal consisting of one ounce of liquid malt mixed with one ounce of gluten and the usual quantity of water, a stomach fluid giving the following figures: Total acidity, .340; free HCl, .132; combined chlorin, .190, an increase of free HCl in this case of nearly eighty per cent, and also an increase of combined chlorin, which could be attributed to nothing except the malt, thus demonstrating very clearly the peptogenic property of the malt.

In another paper now in preparation, of which this is a brief abstract, prepared for this occasion, I hope to present, by means of a detailed report of a large number of experiments, the views which are scarcely more than hinted at in this paper, in a clearer light, and, if possible, with still more conclusive facts.

The interesting researches relating to the chemistry of digestion which have been conducted in Germany within the last few years, by Boas, Ewald, Leube, and others, and the considerable degree of success which has attended the application of these results to therapeutics, has recently created an unprecedented interest in a class of disorders which, although exceedingly common, and perhaps invested with greater intrinsic importance than any other class of ailments, has heretofore been very greatly neglected. For some time the methods formulated by German investigators, particularly the colorimetric methods of Ewald and Boas, were accepted without question as a satisfactory means of precise diagnosis, in consequence of the evident advantages which they presented over methods in former use. Investigators in other countries, particularly in France and England, however, as well as practical clinicians in the leading medical centers of Germany, soon began to discover serious defects in the practical application of these new methods of examining stomach fluids. This skepticism has led to important experimental inquiries for the purpose of determining more accurate means of diagnosis.

My own interest in this subject has been stimulated by a desire to meet to the fullest degree possible, the therapeutic demands of the patrons of an institution which receives annually several thousand persons suffering from chronic ailments of various sorts, a large proportion of whom present some form of digestive disturbance. Some twenty years' experience in the treatment of chronic invalids in this establishment has thoroughly convinced me of the paramount importance of precision in diagnosis in relation to digestive disorders, not only in the treatment of maladies generally recognized as having their seat in the stomach, but in various dyscrasies and chronic maladies which, until very recently, at least, have not been recognized as having any very direct relation to digestive derangements.

My purpose in this paper has been to call attention to the accurate methods which are now available in the study of the functional disorders of digestion through the exact chemical examination of the stomach fluid obtained after a test meal, and to the interesting experimental inquiries which these methods enable us to undertake, whereby it is possible to ascertain exact facts of great importance in relation to the hygiene and therapeutics of this very large class of ailments.

In the great majority of cases,—and usually those in which the greatest and most rapid improvement has taken place,—I am not able to show the results by comparison of the analyses of stomach fluids, for the reason that only one examination was found necessary, and the patients, being satisfied with their improvement, did not care to submit to a second examination merely for scientific purposes. A second examination has been made, however, in 516 cases, and in 127 cases, more than two examinations have been made, so that I have had abundant opportunity not only to test the accuracy of the method, but to demonstrate its value as a guide in the application of therapeutic measures. However, I might append many scores of cases as illustrative of the excellent therapeutic results obtainable by the employment of this exact method of directing therapeutic effort. But as this paper is already longer than I desired to make it, I will only add the following briefly stated cases, as illustrative of the practical results obtainable after the failure of other methods: —

Case I.

The patient, Mr. C——, a professional man, aged forty-two years, had suffered for a number of years from disturbances of digestion, which had finally reduced him almost to a skeleton, and rendered him incapable of pursuing his ordinary professional duties. After consulting numerous specialists, and employing all the means within his reach, he finally came to the Battle Creek Sanitarium. On examination, the patient was found to be suffering from marked dilatation of the stomach, with considerable hyperesthesia of the lumbar ganglia of the sympathetic and the solar plexus; was very anemic, the blood count being 4,880,000; was unable to digest anything. Within a few hours after taking food into the stomach, the patient invariably began to suffer pain in the left temple, which gradually increased until he became nearly beside himself. Relief was obtainable only by evacuation of the stomach. The stomach was unable to tolerate the smallest amount of free fat, and its aversion to starch in any form was almost equal. The results of the examination of the stomach fluid at the beginning of treatment, and again four months later, are shown in the table below. In the first column are given the results of the first examination; in the second column, those obtained in the last examination. A number of examinations were made during the four months the patient remained under treatment, most of which showed progress in the direction of improvement: —

	Normal quantities.	1.	2.
Total acidity	(.180–.200 gms.)	.232	.184
Calculated acidity	" "	.300	.182
Total chlorin	(.300–.330 ")	.418	.366
Free HCl	(.025–.050 ")	.054	.030
Combined chlorin	(.155–.180 ")	.246	.152
Fixed chlorids	(.100–.110 ")	.114	.184
Coefficient of albumen digestion	(1.00)	.70	1.00
" " starch	(1.00)	.67	.46
" " salivary activity	(1.00)	2.00	.50
Fermentation	(0.00)	6.	3.
Chlorin liberation		1.10	.75

By a comparison of the figures given in columns 1 and 2, it will be noted first, that the patient was suffering at the beginning of treatment with extreme hyperpepsia, the calculated acidity being 50 per cent higher than normal. It will also be noted that the coefficient for the digestion of albumen was 30 per cent below normal, indicating the development of a large amount of toxic albuminoid substances in the stomach from the imperfect digestion of proteids, a fact which could be ascertained in no other way except by this method of investigation.

The figures given in column 2 indicate a return to the normal standard in the most important particulars. Both the total acidity and the calculated acidity are normal. The amount of free HCl, which in the first examination was nearly forty per cent. above normal, was practically normal. The coefficient of albumen digestion was normal, and the coefficient of chlorin liberation, which was 10 per cent too high in the first examination, was even a little below normal. The coefficient of starch digestion was below normal, being even lower than at the first examination. This was evidently due to a temporary change in the efficiency of the saliva, which happened to be at this time 50 per cent, or one fourth that found in the first examination. I know of no reason for this change, but have frequently noted a fluctuation of this kind in the digestive power of the saliva. I find that the saliva, like the gastric juice, is variable in quality, in rare cases presenting a degree of efficiency ten or twelve times the normal, while in other cases it is much below the normal standard. So great a variation as this, however, is not observed in individual cases, although cases are not infrequently encountered in which the saliva shows at times double or even more than double the efficiency which it does at other times.

Improvement in the patient's general symptoms was as great as that indicated by the examination of the stomach fluid. He gained nearly twenty pounds in flesh, was relieved of the headache, no longer required the use of the stomach-tube, and was wonderfully improved in general vigor. He still, however, found it necessary to exercise great care in diet, on account of the permanent disability resulting from the extreme dilatation of the stomach. The important things to be gained in a case of this kind are the correction of morbid processes in the stomach, improvement, so far as possible, in the muscular tone of the organ, and the establishment of a dietary adapted to the patient's condition.

Case II.

Miss C——, aged thirty; received into the institution Aug. 20, 1895 The leading symptoms presented were distention after eating, accompanied by nervousness, depression, headache, giddiness, palpitation of the heart, disturbing dreams, thickly coated tongue, sour and offensive breath. The patient was thin in flesh, weak, and unable to continue the duties of her profession. Examination of the blood showed the hemoglobin to be 79 per cent of what it should be, and the blood count 4,400,000.

The results of the examination of the stomach fluid at the beginning of treatment, and again after a few weeks' treatment, are shown in the following table: —

	Normal quantities.	1.	2.
Total acidity	(.180–.200 gms.)	.100	.174
Calculated acidity	" "	.100	.270
Combined chlorin	(.155–.180 ")	.170	.270
Coefficient of albumen digestion	(1.00)	.55	.67
" " starch	(1.00)	.55	.71
Fermentation	(0.00)	5.	0.

The physical condition of the patient had improved correspondingly in every respect. The stomach, which was at first prolapsed two inches below the umbilicus, was restored to normal position. The improvement in the blood was shown by an increase of hemoglobin to 93 per cent. The fermentation had disappeared, and the amount of work done by the stomach in the digestion of albumen had nearly doubled, while the starch digestion had improved nearly 30 per cent. The patient was discharged practically well, with the understanding that she would continue to exercise care in regard to diet, and should for some time longer employ such exercises and simple measures of treatment as had been found advantageous.

Case III.

Mrs. H——, aged fifty-one years. The patient was much emaciated, having been a chronic invalid for many years, suffering from eructations of gas, regurgitation of food, nausea, daily pain, burning, faintness, heaviness at the stomach, aortic palpitation, gaseous distention of the bowels, constipation, drowsiness after meals, morbid taste, dryness of the throat, accompanied by great thirst. On examination of the stomach, it was found to be prolapsed three inches below the umbilicus, the patient having an inguinal hernia on her left side. The right kidney was prolapsed. The patient had suffered from most of the symptoms present for fourteen years. The liver was prolapsed to the umbilicus, and had been mistaken for an ovarian tumor. The patient suffered frequent attacks of jaundice, accompanied by intense itching of the skin; had been steadily losing flesh for a long time. The hemoglobin was found to be 70 per cent of the normal. The results of the first examination of the stomach fluid in this case are shown in column 1 of the following table; the results of the second examination, made a few months later, are shown in column 2:—

	Normal quantities.	1.	2.
Total acidity	(.180–.200 gms.)	.020	.080
Calculated acidity	" "	.086	.112
Total chlorin	(.300–.330 ")	.238	.128
Coefficient of albumen digestion	(1.00)	.23	.71

This patient's case required not only long and faithful treatment, but also an operation for the cure of the inguinal hernia, and for the restoration of the kidney to normal position by nephrorrhaphy. While operating upon the hernia, the opportunity was improved to replace the stomach, suturing it in such a position as to support the liver also. The stomach was held in position by buried silkworm-gut sutures, carefully sterilized, and did not give any apparent inconvenience.

As will be noted by a comparison of the figures given, the coefficient of albumen digestion improved more than 300 per cent. The total amount of normal work done by the stomach was proportionately increased. The patient accordingly made a very appreciable gain in strength, flesh, and blood. On leaving the institution, examination of the blood showed hemoglobin 93 per cent, blood count 4,150,000.

Case IV.

Mrs. I——, aged twenty-five, a recent patient, had suffered for six years from indigestion, with constant pain in the stomach, and occasionally severe chronic pains and fainting, which were relieved only by an emetic. During the first year of her invalidism she was troubled only during the summer, but for the last year the stomach disorder had been constant. The patient complained of a bitter taste in the mouth, heaviness after meals, flatulence, severe constipation, requiring the daily use of the enema, giddiness, swelling of the hands and feet, pain in the region of the heart followed by fainting, extreme nervousness, insomnia, attacks of vomiting, and frequent loss of consciousness (nervous apoplexy). Pepsin, purgatives, tonics of all sorts, dieting, etc., had been employed, but without benefit. The patient was steadily getting worse, and at the time she arrived she could scarcely rise from her chair without assistance. The tongue was exceedingly foul. Examination of the blood showed marked anemia, the hemoglobin being seventy-five per cent. of the normal, and the blood count 3,700,000, or eighty-two per cent. of the normal number. The white corpuscles were reduced to a greater extent than the red, there being only sixty-one per cent. of the normal. Physical examination of the stomach showed its lower border to be three inches below the normal position. There was extreme hyperesthesia of all the lumbar ganglia of the sympathetic. The patient had also some pelvic pain, probably due to a diseased condition of the left ovary, which was prolapsed and very sensitive; but this evidently had very little to do with the patient's general suffering.

Examination of the stomach fluid showed very marked hyperpepsia, the following figures being obtained: —

Total acidity (A)	.276 gms.
Calculated acidity (A′)	.288 "
Total chlorin (T)	.366 "
Free HCl (H)	.058 "
Combined chlorin (C)	.230 "
Fixed chlorids (F)	.078 "
Maltose (M)	1.440 "
Dextrin and soluble starch	.980 "
Fatty acids (from fermentation) (L)	.005 "

The following figures were obtained for the coefficients: —

a, Digestion of proteids	.92
b, Starch digestion	.74
c, Salivary activity	.30
Fermentation	5.
Solution	.96
Absorption	.15

The patient was placed at once upon a dietary consisting of granose, a perfectly dry preparation of wheat, in thin, thoroughly cooked, well-baked flakes, and bromose, a preparation of malted nuts in which the starch is digested and the fat emulsified. Lavage was ordered at the outset, and at its first application there was brought from the stomach an astonishing amount of undigested food, the result of the slow absorption. Before coming to the Sanitarium, the patient had been living upon malted milk and cream, the worst possible food for a person in her condition, a dry diet being indicated. A change of diet and the application of Swedish movements, stomach massage, fomentations, electricity, tonic baths, and other measures, secured immediate relief from suffering, and by the beginning of the second week the patient showed a gain in flesh. At the end of three weeks she was walking several miles daily. She had gained in fourteen days exactly fourteen pounds of flesh. The dynamometer showed a total increase of strength amounting to 825 pounds. The patient's cheeks were rosy, her lips red, eyes sparkling, and tongue clean. The old symptoms had disappeared, and she declared that she was well enough, and insisted on going home against protest, as a sufficient time had not yet elapsed to insure permanency in the improvement, except under the specially favorable conditions of a rigid regimen and carefully adjusted treatment.

This case is introduced as an indication of what can be done for the relief of stomach disorders by the exact adaptation of diet, regimen, and treatment to the patient's condition.

Many similar cases might be cited. One lady, for example, gained twelve pounds of solid flesh in one week. It is more common, however, for patients to gain more slowly, but a rate of three or four pounds a week is not uncommon. A gentleman patient reported an increase of forty-six pounds in six weeks. A chronic dyspeptic, who had been confined to the bed for several months, and under the so called Salisbury treatment had made no progress toward recovery, gained a pound a day for four weeks.

These cases might be multiplied at great length. Of between four and five thousand cases which have been treated by the methods outlined in this paper, those have been very rare indeed which have not been greatly and rapidly benefited. Many instances might be recorded in which patients gained from ten to forty pounds of flesh within a few weeks, being meanwhile actively engaged in appropriate gymnastic exercises, — a fact worthy of mention, since flesh and blood obtained in connection with proper muscular work is a much more valuable acquisition than that secured by rest-cure methods alone, in which case the gain often disappears with great rapidity when the patient is placed upon his feet. I do not, however, wish to discount the importance of flesh and blood acquired by means of the rest-cure, as that is an invaluable measure when other means fail; but a gain of flesh under work indicates a change for the better in vital conditions, which gives promise of permanency in the patient's improvement.

Patients improve under exercise not only in flesh but in strength. The total strength, as tested by the dynamometer, has been frequently observed to increase from five hundred to fifteen hundred pounds in a single month. It is not an uncommon thing for patients to more than double their total strength within a few weeks.

This nice adaptation of treatment and diet to the patient's condition is only possible by the aid of an exact diagnosis. The technical details of the method employed I shall undertake to give in another paper. It will also appear as an appendix to a recent work on the stomach by Debove and Rémond, which the writer is now translating from the original French, and which will soon be published by the Modern Medicine Publishing Company.