AN EXPERIMENTAL STUDY OF THE ACTION OF OIL ON GASTRIC ACIDITY AND MOTILITY.

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This investigation was commenced with the idea of perfecting a method of experimentation on the human stomach which has been employed more or less systematically in the medical clinic of the University Hospital for a number of years.¹ Much of the knowledge concerning the action of the various drugs and remedies administered in the treatment of stomach disorders has been deduced from the results of purely empirical procedures. In recent years, however, quite a number of scientific experiments have been conducted, particularly in Europe, which furnish the profession much useful information concerning food reactions in the stomach. Some of the methods employed to solve certain problems regarding digestion are fairly accurate, while others are subject to more or less criticism; consequently the chief aim of this study has been to overcome these defects in so far as possible. Notwithstanding the difficulties of this task, it seemed possible that by paralleling Pawlow's classic experiments on dogs one might obtain evidence justifying the conclusion that all reactions obtained by experimentation on canines with miniature stomachs occur to a greater or less extent in man.

The authors had been employing olive oil as a routine treatment for hyperchlorhydria in all its forms, both in hospital and private practice, for a number of years, with such favorable results that the desirability of determining its effects on the gastric functions experimentally prompted the present investigation herewith reported. Results of clinical observations, which are not based on technical experimentation, have revealed many indisputable truths concerning digestion, but the science of medicine will be advanced greatly if these observations can be confirmed and the action of drugs demonstrated by actual experiment.

It is an ancient idea that fats retard digestion. Aristotle evidently observed phenomena of this nature before expressing the opinion: "Now the best digestion is in the bottom of the stomach, because the fat

1. Cowie: Physician and Surgeon, Detroit and Ann Arbor, 1903, xxv, 241-252.

descends not there; such as eat fat meat are very sleepy, by reason that digestion is hindered." Pawlow² has aptly said that "physiology stood for a long time in sharp conflict with practical medicine. Physicians bringing forward their observations in proof had long answered the question in the affirmative. . . .

"Physiologists, on the other hand, had fruitlessly endeavored, for decades, to arrive at definite results." Dr. Chigin,² working in Pawlow's laboratory, demonstrated that fat and starch have no exciting effect on the glands of the dog's stomach. Pawlow devoted particular attention to the investigation of vegetable and animal fats. "They were tested not alone on a dog with an isolated miniature stomach, but also on animals with gastric and esophageal fistulæ, and finally on dogs which had survived the operation of separation of the vagi in the neck, performed several months previously." In all cases the fat was directly introduced into the stomach without swallowing. The results were negative.

When this experimenter poured 100 c.c. of oil into the main stomach of a dog by means of a "sound," and one-half to one hour later the dog was given 400 grams of flesh, instead of the usual five to ten minutes, half an hour elapsed before the beginning of secretion, and when it commenced it was scanty, only three to five c.c. being collected in from two to three hours, while under other conditions ten to fifteen c.c. were secreted in the same time. When the oil was introduced into the stomach immediately after eating the meat, "the secretion began with normal energy, and only later did the inhibitory influence make its appearance." "The same results were obtained when the dog was given fat mixed with meat." A lowering of the digestive function as well as the amount of juice was noticed.

Pawlow concludes that "fat depresses, that is, inhibits the normal energy of the secretory process," and is forced to the further conclusion that this inhibition is central, by reflex stimulation of the inhibitory nerves of the glands, or the inhibitory centers of these nerves, and not to the mere mechanical effect of covering over the mucous membrane and preventing excitation of the nerve endings.

Backman,³ in his investigation, first washed the fasting stomach with warm water, after which he administered daily alternations of fat and fat-free food. Samples were obtained by expression, at intervals of one-quarter to one-half hour, until the stomach was empty, which was proved subsequently by washing. Similar investigations with and with-

2. Pawlow: *The Work of the Digestive Glands*, lecture, translated by W. H. Thompson, London, 1903, 80.

3. Backman: *Ztschr. f. klin. Med.*, 1900, xl, 224.

out the fat were usually conducted two or three times with the same meal. Unfiltered contents were used for the determination of the acids. The meals employed were the following:

- I. French bread 100 grams.
Butter 50 grams.
Water 300 grams.
- II. French bread 100 grams.
Cream 300 grams.
- III. Oatmeal porridge, made of 6 grams of oatmeal, steamed with enough water to make 357 grams. To this 50 to 199 grams of butter were added during the cooking.

From his investigations Backman concluded that HCl was decreased from 2 to 42 per cent. by the employment of fat, these figures being obtained with the cream meal. He also found that butter delayed the appearance of free HCl in one of his cases, and that cream delayed it in two cases out of three. The rise of the acidity curve, which is slower with fat than without, often lasts until the end of digestion, exhibiting marked contrast with the control meals, in which the highest values for free HCl are in the middle of the digestion period. In other words, there is a decline in the secretion of the gastric juice and a lengthening of the time of digestion when oil or fat is ingested with the meal.

Strauss and Aldor⁴ report experiments on seven cases of hyperchlorhydria. Their purpose was to determine the effects of the substitution for carbohydrates of fat given in abundance, but in quantities not so large as to cause discomfort of the patient or to interfere with the assimilation of fat. They employed three sets of meals:

- I. Control meal, consisting of one roll and 300 c.c. of tea.
This was allowed to remain in the stomach one hour.
- II. Gum arabic meal, consisting of one roll, 300 c.c. of tea, and 5 grams of gum arabic.
- III. Oil meal, consisting of one roll, 300 c.c. of tea, 5 grams of gum arabic, and 30 grams of oil of sweet almonds.
- IV. Olive oil meal, consisting of one roll, 300 c.c. of tea, 5 grams of gum arabic, and 60 grams of olive oil.

Seven cases in all are reported. All the cases, except 2 and 5, received two control meals. Cases 3 and 4 received one initial meal and one gum meal as control. In five of the cases there was a diminution in the values of the acids as contrasted with the controls. This was marked in Cases 1, 3 and 4. Cases 2, 3, 4 and 7 show variations which are certainly not marked, except in Case 3, where, after the gum meal, the HCl value rose from 8, with the previous meal, to 35, and fell to 10 and 6

4. Strauss and Aldor: *Ztschr. f. Diätet. u. physik. Therap.*, Leipzig, 1898, i, 117.

with the oil of sweet almond meal. The increase from 8 to 35, the authors assert, is due to the action of the gum arabic, which had a similar action in nearly all of the cases. So far as this part of their work is concerned, Strauss and Aldor reach the conclusion that oil depresses the secretion of acid. It would seem that their cases were not sufficiently controlled nor sufficient in number to justify very definite conclusions.

Ewald and Boas⁵ employed a test meal consisting of 1 to 2 per cent. starch paste and pure neutral olive oil in the proportion of four to one. They conclude that after the administration of a mixture of paste and oil, as contrasted with paste alone, no free HCl appears during the first half-hour.

Akimow-Peretz⁶ investigated the effect of the daily administration of almond oil over long periods. Fifty to 100 c.c. were given before eating. A lowering of the acidities in 16 out of 18 cases was found. An emulsion of almonds made by grinding up a tablespoonful of sweet almonds into a meal, and adding boiled water, so that the amount of the strained fluid, after thoroughly shaking, equaled about 300 c.c., gave similar, but not so marked, results.

ORDER OF AUTHORS' INVESTIGATION.

1. The patient was chosen with much care. He was one who had first become thoroughly familiar with the manipulations of the stomach tube, that is, he could swallow it without discomfort or retching, was able to retain it for an indefinite period of time, and to prevent the saliva from entering the stomach in any undue amount. The cases studied at the University Hospital were admitted for stomach complaints. Those patients examined at the Craig Colony presumably had normal stomachs; at least none of them complained of gastric symptoms.

2. A uniform test meal was employed in each case so that the food stimulation would not vary from day to day. It was given at approximately the same time each day and was removed from the stomach at a definite time after eating. The patients studied at the University Hospital were given a shredded wheat biscuit, which has a fairly constant weight of 30 grams, and, after eating this dry, 300 c.c. of water. At the Craig Colony, 30 grams of very dry toast, with at first 400 c.c. and later 300 c.c. of water, were given. Olive oil was used almost exclusively at the University Hospital. Cotton seed oil was given preference at the Craig Colony, olive oil being used only a few times.

3. After the secretion range was established by a series of meals the

5. Ewald and Boas: *Arch. f. path. Anat. (etc.)*, Berl., 1886, civ, 271.

6. Akimow-Peretz: *Abstract, Arch. f. Verdauungskr.*, Berl., 1898, iv, 397.

oil was given at a definite time in relation to the meal and the examinations conducted in the same way as with the controls until a sufficient number were obtained. If the patients remained in hospital long enough, the oil was withdrawn and the tests continued.

4. Two series of experiments were conducted in every case, one as described above, where the contents were recovered one hour after ingestion, and the other by what is designated the special meal series, in which samples were removed from the stomach at frequent intervals, 5, 10 or 15 minutes, until the stomach was empty. A final lavage was given to assure the removal of all food from the stomach; a definite amount of water was employed. The reactions of the fluid obtained after the lavage were also tested. In the beginning of the investigation, the tube was allowed to remain in the stomach during the entire stage of digestion. Later the tube was removed after each sample was obtained.

5. The chemical analyses consisted in the estimation of free HCl with di-methyl-amido-azo benzol as indicator; of the total acidity with phenolphthalein as indicator; of peptic strength by Mett's method.⁷ To eliminate the personal equation, each case was studied by the same person. This rule was rarely broken. However, we had determined by testing ourselves that we read to the same end reaction.

By adhering as closely as possible to these procedures and by examining a sufficient number of cases, we have hoped to eliminate many factors of error which must necessarily exist in an investigation of this nature.

The effect of oil was investigated on three definite functions of the stomach—on the rate and height of secretion and on the drainage or motor power of the stomach. Final conclusions concerning each of these are based on comparisons of the average results of large numbers of meals with and without oil administered in definite relation to the meal.

ILLUSTRATIONS OF THE IMPORTANCE OF CARE IN THE SELECTION OF SUITABLE CASES FOR EXPERIMENTATION.

The following cases are only a few of the many that can be given from the clinical records of the University Hospital illustrative of how useless any investigation would be without first having controlled the range of secretion by keeping the subject under the same conditions from day to day. It was pointed out many years ago by Ewald, in the first edition of his *Klinik der Verdauungskrankheiten* (1888), that there is often a daily difference of from 20 to 27 degrees of acidity in

7. Cowie: Physician and Surgeon, Detroit and Ann Arbor, 1904, xxvi, 118-121.

the normal stomach. From a perusal of the literature it would seem that this fact had not been much considered.

CASE 1.—Louis M.

	Free HCl.	Total acid.
Dec. 16, 1904.....	26	42
Dec. 17	0	16
Dec. 18	0	12
Dec. 19	10	28
Dec. 20	22	40
Dec. 21	30	46
Dec. 22	34	52
Stimulus equivalent to an Ewald test breakfast.		

CASE 2.—Miss A. K.

	Free HCl.	Total acid.
Feb. 23, 1905	28	28
Feb. 24	40	48
Feb. 25	48	60

CASE 3.—Mr. B.

	Free HCl.	Total acid.
Oct. 4, 1904	0	4
Oct. 5	0	15
Oct. 7	0	15
Oct. 8	0	12
Oct. 26	0	10
Oct. 27	0	20
Oct. 28	10	35
Nov. 7	0	50
Nov. 15	10	30
Nov. 16	8	26
Feb. 22, 1905	0	30
Feb. 24	0	28
Feb. 25	0	14

CASE 4.—A young man with hyperacidity. The fasting stomach showed, on March 24, the presence of HCl and pepsin. After a shredded wheat biscuit meal, samples were taken every fifteen minutes. The first appearance of HCl (Günzburg) was noted at 52 minutes. The highest HCl value, 42, was obtained at 67 minutes. The stomach was empty at 112 minutes, and the total amount recovered during this time was 151 c.c. The following day, March 25, the fasting stomach was empty. Two ounces of cotton seed oil were given one-half hour preceding the shredded wheat biscuit meal. The first appearance of free HCl was at 69 minutes. The highest free HCl value, 31, was obtained at 129 minutes. The stomach was empty at 159 minutes, and the total amount recovered during this time was 218 c.c. April 1, two ounces of cotton seed oil were given, as before. There was no HCl secreted during the hour. April 2, no oil preceded the biscuit meal, and no HCl was secreted.

In Cases 1 and 3 one could easily choose three successive meals which might suggest a condition directly opposite to that which was dominant. Case 4 shows how incomplete work might have given an apparent basis for very definite conclusions as to the action of olive oil. Had the fourth meal not been given, the conclusion might have been reached that an excellent demonstration of the depressant action of oil on the acidity had been obtained. The fourth meal, however, obviates any such conclusion and shows that the secretion in this case was disturbed by nervous influences.

SERIES 1.—The following are the cases studied at the University Hospital:

CASE 5.—Mr. F. This patient had a distinct chemical hyperchlorhydria without subjective symptoms, excepting constipation. He had attacks of nocturnal unconsciousness, accompanied by vomiting and frothing at the mouth, followed by pain in the stomach and soreness of the abdominal muscles. No attacks during investigation.

Chart 1, Case 5.—Mr. F. Record of daily meals. Total acid indicated by upper (heavier) solid line. Free acid indicated by lower solid line. Average total acidity indicated by upper dotted line. Average HCl indicated by lower dotted line.

EXPERIMENT 1.

Date.	Quantity.	Free HCl.	Total acid.	
Sept. 30.....	30 c.c.	27 c.c.	40 c.c.	Control.
Oct. 1.....	35	7	19	Control.
Oct. 2.....	160	54	66	Control.
Oct. 6.....	120	49	63	Control.
Oct. 7.....	15	50	70	Control.
Oct. 8.....	10	20	32	Control.
Oct. 9.....	10	50	65	Control.
Oct. 10.....	40	62	76	Control.
Oct. 11.....	40	52	64	Control.
Oct. 12.....	7	40	50	Control.
Oct. 13.....	..	40	50	Control.
Oct. 14.....	0	..	..	Control.
Oct. 15.....	75	76	88	Control.
Oct. 16.....	75	72	84	Control.
Oct. 17.....	25	57	80	Control.
Oct. 18.....	..	51	70	Control.
Oct. 19.....	75	62	80	Oil, 1 oz. after.
Oct. 20.....	50	52	69	Oil, 1 oz. after.
Oct. 21.....	30	54	70	Oil, 1 oz. after.
Oct. 22.....	172	24	34	Oil, 1 oz. after.
Oct. 23.....	48	55	70	Oil, 1 oz. after.
Oct. 24.....	40	55	75	Oil, 1 oz. after.
Oct. 25.....	110	60	82	Oil, 1 oz. after.
Oct. 26.....	75	58	72	Oil, 1 oz. after.

Date.	Quantity.	Free HCl.	Total acid.	
Oct. 27.....	175	4	16	Oil before.
Oct. 28.....	180	10	20	Oil before.
Oct. 29.....	208	12	28	Oil before.
Oct. 30.....	..	15	25	Oil before.
Oct. 31.....	5	0	10	Fasting stomach.
Nov. 1.....	150	60	78	Oil after.
Nov. 2.....	115	45	57	Oil before.
Nov. 3.....	254	17	28	Oil before.
Nov. 4.....	210	32	42	Oil before.
Nov. 5.....	228	18	28	Oil before.
Nov. 6.....	60	40	65	Oil before.
Nov. 7.....	Special meal.			
Nov. 8.....	Special meal.			
Nov. 9.....	Special meal.			

EXPERIMENT 2.

CASE 5.—Mr. F. Control meal. XI-9-1903.

Time.	Amount.	Free HCl.	Total acid.	Pepsin.	Pepsinogcn.
6:35	Began eating.				
6:42	Finished eating.				
6:45	10 c.c.	0 c.c.	0 c.c.	0 c.c.	3.61 c.c.
6:50	11	0	0	0	6.7
6:55	9.5	4	10	0.36	13.6
7:00	12	10	21	2.56	
7:05	11	19	32	4	
7:10	10	21	40	9	
7:15	10.5	20	40		
7:20	10	25	50	6.7	
7:25	10	30	56	9	
7:30	11	40	60	12.2	
7:35	10	40	62	10.9	
7:40	9.5	48	68	15.2	
7:46	10	40	68	16	
7:50	10	30	52	11.2	
7:55	5	28	50	9.61	
8:00	Lavage. Practically clear. Free HCl, 11 c.c.				

Meal with oil immediately before eating. XI-7-1903.

8:10	Began eating.				
8:17	Finished eating.				
8:20	10 c.c.	0 c.c.	0 c.c.	..	2.89 c.c.
8:25	11	0	7	..	2.56
8:30	10	0	0	..	1.4
8:35	13	0	7.5	..	2.56
8:40	11	10	20	..	3.24
8:45	10	10	20	..	4
8:50	10	0	10	..	
8:55	11.5	18	30	..	3.24
9:00	8	16	28	..	4.41
9:05	11.5	16	30	1.96	
9:10	10.5	20	29	..	
9:15	10	19	28	6.76	
9:20	10	40	57	9	
9:25	10	40	50	10.9	
9:30	10	30	46	9	
9:35	10	32	42	4	
9:40	5	33	45	9	
Lavage clean. Free HCl, 10 c.c.					

In Charts 2, 3, 7, 8, 9, 10 and 11 the figures at the top in minutes represent the time subsequent to the beginning of eating.

Chart 2, Case 5.—A, control. B, olive oil immediately preceding the meal. C, olive oil immediately after the meal.

CASE 5.—Mr. F. Oil immediately after meal. XI-8-1903.

Time.	Amount.	Free HCl.	Total acid.	Pepsin.	Pepsinogen.
8:15	Began eating.				
8:23	Finished eating.				
8:25	10 c.c.	0 c.c.	0 c.c.	..	15.3 c.c.
8:30	10.5	0	0	..	12.9
8:35	10	5	7	..	14.4
8:40	10	0	7	..	8.4
8:45	10	5	10	0	
8:50	10	26	13	..	
8:55	10	20	28	10.5	
9:00	10	30	40	24	
9:05	10	20	28	13.4	
9:10	10	30	38	18.5	
9:15	10	28	35	27	
9:20	10	30	40	22	
9:25	11	31	38	18.5	

Time.	Quantity.	Free HCl.	Total acid.	Pepsin.	Pepsinogen.
9:30	10	32	46	19.4	
9:35	10	40	57	18.5	
9:40	10	43	57	20	
9:45	8	40	55	23	
9:50	*Lavage about clean. HCl, 15 c.c.				

*Order of investigation.

From a study of these tables and the accompanying charts the following deductions can be made:

1. In the daily meals, Table 1, the oil was given in close relation to the meal. When it was given immediately after the meal, there was practically no change in the acid values over those of the control meals, but the progress of digestion was somewhat delayed. When the oil immediately preceded the meal, a decided decrease in the amount of the free acid was noticed. On November 1 a mistake was made and the oil given immediately after the meal, and the same result was obtained as in the previous administration of oil at this time. However, on November 2 and 6 a somewhat similar comparative lack of depression occurred when oil was administered before the meal.

2. The special meals show that the appearance of free HCl is distinctly delayed when oil is given before the meal, but is unaffected when oil is given after the meal. The height of secretion is greatest when oil is not used; it is apparently slightly lowered when oil is given either before or after the meal, and is distinctly delayed when oil is given after the meal.

3. The rate of increase in the quantity of free HCl is delayed by oil before or after the meal; this delay is more marked when oil is given before the meal. The curve of the rise of the acidity may be said to be concave with oil and convex without oil. Taking the readings one hour after each of the special meals, the free HCl is distinctly lower where oil was administered before the meal than after meals without oil; when oil was given after the meal it is only slightly lower, corresponding closely with the results obtained in the daily meals. The case did not remain long enough to enable any conclusions as to the permanency of the effect of the oil treatment. This will be discussed later.

4. Variations in the amount of HCl observed may be due not to the lessened secretion, but to the retarded secretion. In the special meals the secretion often rises as high, but the rise is markedly delayed by the oil, and at the end of the usual time at which a test meal is removed from the stomach the acid value is distinctly lowered.

CASE 6.—Mr. J. Peptic ulcer; subacute; hypersecretion; robust railroad conductor; symptoms of hyperchlorhydria marked. Operation, gastroenterostomy; recently active ulcer; recovery complete.

Chart 3, Case 6.—Mr. J. Experiment 1, control meal indicated by solid line. Olive oil meal indicated by dotted line.

EXPERIMENT 1A.—MR. J., SHREDDED WHEAT BISCUIT MEAL WITHOUT OIL.

Time.	Quantity.	Free HCl.	Total acid.	Peptic value.	Lugol reaction.	Remarks.
7:55 a.m.	After lavage began eating.					
8:00	Finished eating.					
8:03	11 c.c.	03 c.c.	12 c.c.	0.00 c.c.	B V	
8:08	10	20	30	10.24	V B	
8:13	10	33	49	20.25	V B	
8:18	10.5	40	53	16.00	V B	
8:23	10	55	70	12.25	V B	
8:30	10.5	75	90	14.44	V B	
8:31	8.5	78	98	6.25	V B	
8:47	11	40	52	7.84	A C	Viscid.
9:03	11	37	50	6.76	A C	More viscid.
9:18	11	40	57	23.04	A C	Very viscid.
9:28	10.5	40	60	9.00	A C	Less viscid.
9:30	5	..	..	..	..	
9:40	9	32	42	14.44	A C	
9:48	Stomach washed. No HCl in washings.					
9:53	Tube passed, aspiration continued for three minutes, 1 c.c. viscid fluid. No reaction for HCl.					

CASE 6.—Mr. J.

EXPERIMENT 1B.—MR. J., SHREDDED WHEAT BISCUIT MEAL PRECEDED BY OIL.

Time.	Quantity.	Free HCl.	Total acid.	Peptic value.	Lugol reaction.
8:10½	After lavage 50 c.c. of olive oil was taken.				
8:12½	Began eating the test meal.				
8:20	Finished eating.				
8:26	10.5 c.c.	0 c.c.	? c.c.	0	B
8:31	11.0	0	10	0	V B
8:36	12.75	..	15	0	V B
8:41	10.0	10	20	0	V B
8:46	10.0	12	22	2.25	V B
8:51	10.0	20	30	2.89	V B
8:56	10.0	20	30	6.25	B V

Time.	Quantity.	Free HCl.	Total acid.	Peptic value.	Lugol reaction.
9:01.....	10.0	22	33	6.25	B V
9:06.....	10.0	20	30	10.8	B V
9:11.....	10.0	30	40	5.29	B V
9:16.....	10.0	33	45	7.84	B V
9:21.....	11.0	33	44	5.29	V B
9:26.....	10.0	38	48	7.84	B V
9:31.....	10.0	40	55	10.8	V B
9:36.....	10.0	50	62	10.8	B V
9:41.....	11.0	53	70	16.8	B V
9:46.....	11.0	62	78	7.84	BB V
9:51.....	10.0	70	85	7.29	B V
9:56.....	10.0	73	90	10.8	VV B
10:01.....	10.0	73	88	10.8	VV B
10:06.....	10.0	80	92	12.25	VVV B
10:11.....	10.0	82	96	10.08	VVV B
10:16.....	10.0	80	100	7.29	VV B
10:21.....	10.0	76	90	18.49	B
10:26.....	10.0	80	95	22.09	A C
10:31.....	20.0	83	100	28.09	A C
10:31.....	Stomach washed, water returns clear				dimethyl-
	amidoazobenzole.				
10:36.....	11 *	15	30	10.8	B V
10:41.....	5.5	40	50	8.6	B V

Lavage after last sample contained no free HCl.

*Few flecks of meal.

CASE 6.—Mr. J.

EXPERIMENT 2.—ORDINARY DAILY SHREDDED WHEAT BISCUIT MEALS, OIL AS SPECIFIED.

Date.	Quantity.	Free HCl.	Total acid.	
April 9.....	76 c.c.	62 c.c.	72 c.c.	Control.
April 10.....	120	78	88	Control.
April 11.....	120	66	74	Control.
April 12.....	120	70	88	Control.
April 13.....	75	52	60	Control.
April 14.....	65	50	59	Control.
April 15.....	60	52	62	Control.
April 16.....	55	88	81	Control.
April 17.....	280	22	34	Oil before.
April 18.....	130	38.6	54	Oil before.
April 19.....	173	10	26	Oil before.
April 20.....	195	44	60	Oil before.
April 21.....	220	14	30	Oil before.
Average.....	74	62.5	73	8 without.
Average.....	199.6	25.7	41	5 with.

In this case a most pronounced change is seen in the rate and height of secretion, as well as in the motor power. With the special meal there is a distinct lengthening of the digestive period. Digestion, instead of continuing one hour and forty minutes, as it did in the control meal, was lengthened to two hours and ten minutes when the meal was preceded half an hour by oil. In the oil meal the rate of secretion of hydrochloric acid was markedly retarded. With the control meal a free acid value of three was obtained 12 minutes after beginning to eat; with the

oil meal $23\frac{1}{2}$ minutes elapsed before the faintest reaction for free acid could be demonstrated.

The height of digestion, 78, with the control meal was reached in the middle of the digestive period, 40 minutes after beginning to eat, while with the oil meal the height, 82 to 83, was attained at the end of the

Chart 4, Case 6.—Mr. J. Daily meals. The upper and heavier dashed line is the total acidity curve, which is averaged in the solid, heavier line; similarly, the HCl is shown in the lower dashed line and this is reduced to average in the lower solid line.

digestive period, about two hours after beginning to eat. The total output of HCl has, by this time, reached a quantity considerably above that observed in the control meal.

The motor power is distinctly lowered by the oil. With the control 128 c.c. were recovered during the stage of digestion; with the oil meal over twice as much, 277 c.c., were obtained. At the end of one hour, the usual time a test breakfast is permitted to remain in the stomach, the

secretion with the control meal is slightly in advance of that in the oil meal.

With the peptic values there is a change corresponding in each meal with the change in the acids.

Doubtless little reliance can be placed on Lugol's test for starch digestion in an experiment of this character. It would be reasonable to expect that, with 23 minutes of practically achlorhydria, much, if not nearly all, of the starch would have undergone the change to anachrom. With the oil meal anachrom was not obtained until the end of digestion, when the free acid was excessively high. The erythrodestrin stage was quickly reached in each case. For this reason the tests were not continued in the other cases.

The daily meals show similar effects from the oil. The height of the secretion is, however, more markedly lowered with the oil meals. The decrease in motor power in the oil meals is as striking as it is in the special meal, the average amount recovered being nearly three times as much as the control. This rather tends to strengthen the value of the special meal, which, together with the daily meals, may be said to be fairly representative of what actually takes place in this case after oil is administered.

CASE 7.—Mr. N. Stomach neurosis.

Date.	Amount.	Free HCl.	Total Peptic acid. value.	Remarks.
October 27, 1903...	100 c.c.	32 c.c.	70 c.c. 4.84	Control meal.
October 28	74	55	75 4.41	Control meal.
October 29	75	52	66 12.25	Control meal.
October 30	96	50	64 16.00	Control meal.
October 31	74	49	64 5.29	Control meal.
November 1	..	52	64 4.84	Control meal.
November 2	25	45	60 10.24	Control meal.
November 3	60	52	67 4.90	Control meal.
November 4	80	54	66 4.41	Control meal.
November 5	90	26	42 1.60	Oil given $\frac{1}{2}$ hr. before.
November 6	50	50	62 5.10	Oil given $\frac{1}{2}$ hr. before.
November 7	300	0	11 0.00	Oil given $\frac{1}{2}$ hr. before.
November 8	199	58	78 2.60	Oil given $\frac{1}{2}$ hr. before.
November 9	120	56	70 20.50	Oil given $\frac{1}{2}$ hr. before.
November 10	65	39	59 3.01	Oil given $\frac{1}{2}$ hr. before.
November 11	70	60	75 16.00	Oil given $\frac{1}{2}$ hr. before.
November 12	92	66	80 21.78	Oil given $\frac{1}{2}$ hr. before.
November 13	102	32	42 3.02	Oil given $\frac{1}{2}$ hr. before.
November 14	70	52	66 9.93	Oil given $\frac{1}{2}$ hr. before.
November 15	62	38	57 9.27	Oil given $\frac{1}{2}$ hr. before.
November 16	70	54	69 1.06	Oil given $\frac{1}{2}$ hr. before.
November 17	152	0	13 0.00	Oil given $\frac{1}{2}$ hr. before.
November 19	71	60	70	Oil given $\frac{1}{2}$ hr. before.
November 20	118	8	22 0.28	Oil given $\frac{1}{2}$ hr. before.
November 21	68	48	64 14.06	Oil given $\frac{1}{2}$ hr. before.

In this case no special meals were given. The acidity curve for the nine days preceding the oil meals was comparatively constant. The fluctuations were within fairly narrow limits. As soon as the oil is given, wide variations are noted. At one time, November 7, there was no secretion of free acid, and the total acidity was only 11; the motility was also markedly lowered, 300 c.c. being recovered at the end of one hour. After this the fluctuations continued within wide limits, touching zero again in ten days, but with a less marked lowering of the motility. On the twentieth day the HCl dropped to 8, but the same stimulus gave an acidity of 48 on the following day.

Chart 5, Case 7.—Daily meals. The upper broken line is the total acidity curve, which is averaged in the upper continuous line. The HCl is shown in the lower broken line, and reduced to average in the lower continuous line.

If a curve of the average for the control and the oil meals be plotted, a distinct depressant effect from the oil is noted. In the presence of two 0 and one 8 acid values that can not be explained, it is a question whether the average lines should be so low. Omitting the records of November 7, 17 and 20, the average line comes to 40.8. That there is depression from oil on the 5th, 10th, 13th and 15th is unquestioned. On the other days nervous factors may have been at work with which we could not acquaint

ourselves in the period of nine days which seemed long enough for a control. The great variation in the acidity after the beginning of the administration of oil suggested that it would be of interest to continue the observations, but the patient had to leave before a second series of controls could be carried out. Such controls seem very important in order to allow a proper interpretation of this case. There can be no question but that oil has at various times had a decided depressant effect both on the secretions and the motility.

Chart 6, Case 8.—A. P. J. Daily shredded wheat biscuit meals. Upper solid line indicates total acid. Dashed line indicates free acid. Lower and heavy solid line indicates average free acid.

CASE 8.—Mr. A. P. J. Hyperchlorhydria with symptoms. No ulcer.

DAILY MEALS WITH AND WITHOUT OLIVE OIL.

Date.	Amount.	Free HCl.	Total acid.	Peptic value.	Remarks.
November 17, 1903.	40 c.c.	94 c.c.	114 c.c.	1.0	No olive oil.
November 18.....	100	90	106		No olive oil.
November 19.....	100	88	104	5.24	No olive oil.
November 20.....	85	94	112	4.4	No olive oil.
November 21.....	82	93	111	4.4	No olive oil.
November 22.....	80	92	102	5.6	No olive oil.

Date.	Amount.	Free HCl.	Total acid.	Peptic value.	Remarks.
November 23.....	60	96	106		No olive oil.
November 24.....	100	96	112		1 oz. immediately before.
November 25.....	100	80	100		1 oz. immediately before.
November 26.....	100	80	96		1 oz. immediately before.
November 27.....	90	84	96		1 oz. immediately before.
November 28.....	110	84	100		1 oz. immediately before.
November 29.....	125	84	108		1 oz. immediately before.
November 30.....	130	60	86		2 oz. immediately before.
December 1.....	95	70	92		2 oz. immediately before.
December 2.....	105	68	87		2 oz. immediately before.
December 3.....	110	86	102		2 oz. immediately before.
December 4.....	110	58	78		2 oz. $\frac{1}{2}$ hr. before.
December 5.....	130	42	54		2 oz. $\frac{1}{2}$ hr. before.
December 6.....	125	64	84		2 oz. $\frac{1}{2}$ hr. before.
December 7.....	80	48	64		2 oz. $\frac{1}{2}$ hr. before.
December 8.....	95	64	88		2 oz. 10 min. before.
December 9.....	100	54	72		2 oz. 10 min. before.
December 10.....	110	48	60		2 oz. 10 min. before.
December 11.....	95	60	78		2 oz. 10 min. before.
December 12.....	105	64	82		2 oz. 10 min. before.
December 13.....	60	66	76		No oil before.
December 14.....	95	108	118		No oil before.
December 15.....	95	94	108	4.00	No oil before.
December 16.....	110	96	106	6.25	No oil before.
December 17.....	90	84	96	5.03	No oil before.

This case was observed for thirty days. The first control series consisted of seven meals. The second control series, beginning on the twenty-sixth day, consisted of five meals, making twelve control meals in all. The effect of dosage, as well as time of administration, of the oil is well illustrated in the average free hydrochloric acid curve. Two ounces of oil immediately preceding the meal causes a decidedly greater depression than one ounce. Two ounces half an hour before the meal brings about a still more marked depression of the secretions. It would seem that in the second instance the increase in the amount of oil accomplished exactly what increase in time before the meal did in the third instance. Two ounces of oil should spread itself over the gastric mucosa more quickly than one ounce. Two ounces half an hour before the meal has still a better chance to cover the entire gastric mucosa, and consequently it may be argued a greater depression should be brought about. That the greater depression in the third instance is not due to prolonged treatment with oil is shown by the rapid rise of the HCl in the second control series to a point even higher than was reached in the first.

CASE 9.—Mr. L. Hypersecretion with hyperchlorhydria.

EXPERIMENT 1A.

March 9, 1906.—Fasting stomach contained 20 c.c., free HCl 30, total acids 40. After lavage, patient ate a shredded wheat biscuit meal.

Time.	Quantity.	Free HCl.	Total acid.	Pepsin.	Pepsinogen.
7:55	Began eating.				
8:03	Finished eating.				
8:05	13 c.c.	Tr.	7.5 c.c.	0.1	0.6
8:10	13	12.5	15.	5.3	6.7
8:20	14	32.5	37.5	21.1	25.
8:30	12	35	42.5	1.75	
8:40	11.5	32.5	47.5	6.25	10.9
8:50	13	42.5	52.5	18.9	23.
9:00	12	40.	52.5	14.	18.9
9:10	11	35.	50.	16.8	25.
9:20	12	50.	60.	25.	14.
9:30	5	50.	60.		
9:40	4.5	32.5	50.	14.4	
9:43	Lavage shows 5 free HCl.

Chart 7, Case 9.—Mr. L. 1, solid line control; 2, line of long dashes, first oil meal, two ounces oil half hour before; 3, line of short dashes, second oil meal, three ounces oil half hour before.

EXPERIMENT 1B.

March 10, 1906.—Fasting stomach, 8 c.c., free HCl 25, total acid 39. After lavage the tube was allowed to remain in the stomach 6 minutes; 5 c.c. was now obtained showing free HCl 20, total acid 30. Peptic value of fasting stomach 41.5, and of the tube stimulation 16.

Time.	Quantity.	Free HCl.	Total acid.	Pepsin.	Pepsinogen.
8:10	Took 2 ounces olive oil.				
8:40	Began eating.				
8:43	Finished eating.				
8:50	7 c.c.	17.5 c.c.	38 c.c.	12.2	18.9
9:00	9.5	30	35	25	
9:10	10.5	45	60		

Time.	Quantity.	Free HCl.	Total acid.	Pepsin.	Pepsinogen.
9:20	11	50	65	25	
9:30	13	50	65	28	
9:40	12	52	70	16.8	18.9
9:50	10	55	70	7.8	
10:00	10	55	71	33.6	18.9
10:10	11	50	68	37.2	26
10:20	10	50	67		37
10:30	9	40	58	42.2	23
10:45	5	33	53		25
10:47	Lavage. No free HCl.		5	16	9

EXPERIMENT IC.

A third meal, given on a date not recorded. Fasting stomach gave 10 c.c., containing free HCl 46, and total acid 60.

Time.	Quantity.	Free HCl.	Total acid.	Pep-sin P. V.
6:56	After lavage 3 oz. olive oil was given through a tube.			
7:25	Began eating.			
7:30	Finished eating.			
7:33	9 c.c.	8 c.c.	11	1
7:41	10	8	14	0
7:50	11			
8:00	11	21	38	..
8:10	12.5	42	65	19.3
8:20	12	68	85	19.3
8:30	12	59	70	19.3
8:40	10	50	70	19.3
8:50	10	50	70	16
9:00	12	58	70	22
9:10	10	58	80	23
9:20	10	55	72	25
9:30	13	60	78	32.5
9:40	6	60	77	36

The stomach now appeared empty and as the patient was very tired no lavage was given.

SUMMARY.

	Digestive period.	Amount recovered.
Control meal	1:45	121 c.c.
First oil meal	1:65	118 c.c.
Second oil meal	2:15	148 c.c.

In this case there has been little or no depressant effect on the secretions from the oil. The second oil meal shows changes which simulate those in the preceding meals, a slow rise in the free acid as contrasted with the abrupt rise of the control, increasing gradually, with the exception of the 8:20 sample, toward the end of the digestive period, which has been distinctly prolonged. The factor of hypersecretion doubtless plays an important rôle in this case and will be considered later under that head.

SERIES II.

The following cases are those studied at the Craig Colony for Epileptics:

CASE 10.—No. 1416. Mr. H. E. W. Bad heredity. Epilepsy followed typhoid fever. Attacks of grand mal about once a week. No gastric complaints. The test meals consisted of two or two and a half ounces of bread and two glasses of water. Samples were taken every fifteen minutes.

Chart 8, Case 10.—H. E. W. Experiment 1, heavy solid line, total acid of control. Heavy dashed line, total acid of oil meal. Lighter (and lower) dashed line, free acid of oil meal.

EXPERIMENT 1.

June 8, 1906.

Time.	Quantity.	Free HCl.	Total acid.
8:25	Began eating.		
8:48	Finished eating.		
8:50	20 c.c.	17.5 c.c.	21.5 c.c.
9:05	20	18.5	29
9:20	26	24	40
9:35	25	35	49
9:50	21	37.5	52
10:05	30	35	52.5
10:20	8	13.3	26.6

Free HCl, highest, 37.5, at 85 min. Amount recovered, 150 c.c.

June 9, 1906.—Same test breakfast as above.

Time.	Quantity.	Free HCl.	Total acid.
7:45	0.75 oz. cotton seed oil.		
8:20	Began eating.		
8:31	Finished eating.		
8:36	10 c.c.	9 c.c.	14 c.c.
8:50	25	13.5	22.7
9:05	30	17	33
9:25	25	21.5	43.5
9:40	25	23	45
9:55	24	33.4	56.2
10:12	5	30	47.5

Free HCl, highest, 33.4, at 95 min. Amount recovered, 144 c.c.

EXPERIMENT 2.

June 11, 1906.—Shredded wheat biscuit meal.

Time.	Quantity.	Free HCl.	Total acid.
8:24	Began eating.		
8:34	Finished eating.		
8:36	28 c.c.	3.7 c.c.	8.7 c.c.

Time.	Quantity.	Free HCl.	Total acid.
8:52	27	18.5	26
9:12	28	30	41
9:26	25	32	43
9:43	20	42.5	55
10:01	20	41	54
10:20	12	38	48
10:40	4	30	35

Highest free HCl, 42.5, at 79 min.; 164 c.c. recovered.

June 12, 1906.

Time.	Quantity.	Free HCl.	Total acid.
7:30	2 oz. oil per tube.		
8:02	Began eating.		
8:10	Finished eating.		
8:12	22 c.c.	6 c.c.	10.4 c.c.
8:28	20	8	17
8:43	30	24	33.5
9:03	30	34	46
9:20	20	46	58
9:36	20	43	57
9:53	10	..	..

Highest free HCl, 46, at 78 min. Recovered 152 c.c.

This patient had an epileptic attack about 7:30 a. m. preceding the control meal. He came to the laboratory at 8:15, complaining of a headache, and was slightly confused.

EXPERIMENT 3.

June 14, 1906.—Shredded wheat biscuit meal.

Time.	Quantity.	Free HCl.	Total acid.
8:25	Began eating.		
8:34	Finished eating.		
8:35	50 c.c.	7.5 c.c.	11 c.c.
8:50	20	22	33
9:05	20	40	52
9:20	20	35	48
9:35	20	50.7	61
9:50	10	57	67

Free HCl, highest, 57, at 85 min. Amount recovered, 140 c.c.

June 15, 1906.—Shredded wheat biscuit meal with oil.

Time.	Quantity.	Free HCl.	Total acid.
7:00	Oil, 2 oz.		
7:32	Began eating.		
7:38	Finished eating.		
7:40	15 c.c.	6 c.c.	11 c.c.
7:55	15	16	21
8:10	15	18	26
8:25	15	28	38
8:40	15	48.3	57.3
8:55	15	57	69
9:10	15	56.6	68.3
9:25	10	50	60

Free HCl, highest, 57, at 83 min. Amount recovered, 115 c.c.

EXPERIMENT 4.—DAILY MEALS.

Date.	Last seizure.	Quantity.	Free HCl.	Total acid.	
June 19	G. 9:40 p. m.				
June 20		150 c.c.	73 c.c.	86 c.c.	...
July 5	G. 5 p. m.	90	66	80	...
July 6		40	66	76	...
July 7		110	54	68	...
July 9		110	46	56	...
July 10		110	55	69.6	...
July 26		105	54	66	Oil.
July 27		38	50	62	Oil.
July 28		110	63	72	Oil.
July 29	G. 12:25 p. m.				
July 30		12	60	88	Oil.
August 1		70	77	89	Oil.
August 2		90	56	65	...

Total number of daily meals, 12.

Average of 7 meals without oil, HCl, 59.4; total acid, 71. Amount, 100 c.c.

Average of 5 meals with oil, HCl, 60.8; total acid, 75. Amount, 67 c.c.

Chart 9.—Heavy solid line, total acid of control. Lighter solid line, HCl of control. Heavy dashed line, total acid for oil meal, being an average of experiments 2 and 3. Lighter (and lower) dashed line, HCl after oil meal, average of experiments 2 and 3.

SUMMARY.

In this case four experiments were conducted, three special meals and one series of daily meals. The results may be summed up as follows: There is distinct evidence of a depressant effect from oil in all of the special meals. With the control meals the rise of the HCl curve is quicker in all cases, except in Experiment 3. The rate of the secretion

is decidedly lowered by oil, being twenty minutes behind the control in Experiment 1 and about twenty minutes behind the control in Experiment 2. The height of digestion is reached at the end of the digestive period instead of the middle, as in the case of the control in Experiments 1 and 2, while in Experiment 3 practically no change can be noted.

Experiment 4 shows no depressant effect from the oil, but rather a reverse of what has been noted heretofore. In none of the experiments has there been any lowering of the motor power, and in Experiment 4 there seems to be a distinct increase in the motor power.

CASE 12.—Mr. W. Grand mal. No gastric symptoms. Test meals of dry toast and water.

EXPERIMENT 1.

Time.	Quantity.	Free HCl.	Total acid.
7:40	Began eating.		
7:45	Finished eating.		
7:55	22 c.c.	2 c.c.	8 c.c.
8:15	20	11.2	23.2
8:40	20	16	32
9:00	30	16	28
9:20	6	15	32.5

Chart 10, Case 12.

June 28, 1906.—Attack at 12:50 p. m.

Time.	Quantity.	Free HCl.	Total acid.
7:05	Oil given.		
7:40	Began eating.		
7:50	Finished eating.		
7:55	20 c.c.	0 c.c.	4 c.c.
8:15	20	20	27
8:33	20	23	34
9:00	20	27.5	40
9:20	20	Trace	12
9:40	15	0.0	12.5

EXPERIMENT 2.—DAILY MEALS.

Date.	Quantity. Free HCl. Total acid.			
June 23	90 c.c.	32 c.c.	44 c.c.	
June 26	55	38	48	
June 29	4	2	3	
July 3	200	8	16	Oil.
July 5	90	18	30	
July 6	?	26	36	
July 7	65	13	25	
July 9		10	20	Oil.
July 10	95	37	50	Oil.
July 26	18	00	..	Oil.
July 27	76	14	26	Oil.
July 28	80	16	27	

Average of 7 control meals: HCl, 20.7; total acid, 28; amount, 64.

Average of 5 oil meals: HCl, 14; total acid, 28; amount, 92.

SUMMARY.

Experiment 1.—The acidities with the oil were all distinctly higher than with the control. There is, however, a slowing of the rate of secretion in the oil meal, as well as a lowering of the motility. As the observations were made only at intervals of twenty minutes, the extent of the lowering of the rate of secretion can not be determined. The oil meal preceded an epileptic seizure by only a few hours. This may account for the increase in the acidities and the disappearance of the free HCl in the last samples.

Experiment 2.—Twelve meals were given in this series. There is distinct depression of the acidity from the oil and a lowering of the motility. If the averages are compared, distinct depression and decreased motility are noted. In the control meals, taken at random, there is a variation in the free acid values of from 2 to 32, while a corresponding change takes place in the total acid values. It is, therefore, impossible to maintain that the apparent depression in the oil meals is due to oil.

Attacks of the grand mal occurred June 24, at 12:15 p. m., and July 27, at 9:35 p. m. It may be noteworthy that the attack on June 24 was followed by almost complete absence of free acid, and that the attack of July 27 was preceded by a similar observation.

A case showing such wide variations is not suitable for experimentation. The record is presented here because the results of the special meal followed the general rule, showing a decrease in the rate of secretion with oil, and also because it may serve as an illustration of the possible outcome of observations taken at intervals so widely separated—ten days in one instance.

CASE 13.—Mr. A. H. Grand mal. No gastric complaints.

EXPERIMENT 1.

Probably June 17, 1906.

Time.	Quantity.	Free HCl.	Total acid.
8:52	Began eating.		
8:59	Finished eating.		
9:00	15 c.c.	0 c.c.	2 c.c.
9:20	15	8	12
9:35	15	13.5	20
9:50	20	12	34
10:05	17	27	38
10:17	20	18	29
10:36	20	20	32
10:57	35	38	54
11:12	15	22	35
11:27	15	12	24

EXPERIMENT 2.

June 18, 1906.

Time.	Quantity.	Free HCl.	Total acid.
7:00	Oil given.		
7:30	Began eating.		
7:36	Finished eating.		
7:40	15 c.c.	0 c.c.	4 c.c.
7:55	15	16	24
8:10	18	9	13
8:25	20	42	56
8:40	15	40	51
8:55	15	20	34.6
9:10	..	31	42.5
9:25	20	22	35
9:40	15	36.3	49.5
10:00	15	25	40

EXPERIMENT 3.

June 27, 1906.—Dry toast meal. Epileptic seizure the night before experiment.

Time.	Quantity.	Free HCl.	Total acid.
7:45	Began eating.		
7:52	Finished eating.		
8:00	20 c.c.	1 c.c.	4 c.c.
8:20	25	32	41
8:45	10	39	48
Stomach empty.			

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
June 19	100 c.c.	60 c.c.	74 c.c.		
June 20	120	58	73		
June 21	45	46	60		
June 22	70	70	82		
June 23	55	64	74		
June 24	..	..	..		
June 26	10	18	24		G. M., 11:35 p. m.
June 28	20	12.5	75	Oil.	
June 29	10	26	42	Oil.	

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
July 3.....	110	9.9	22	Oil.	Attack before meal.
July ?	75	62	76		9th, 5:20 a. m.
July 10.....	90	27	42		
July 6.....	10	50	90		
July 7.....	80	61	75		
July 9.....	25	56	66		
July 26.....	120	55	63		5:00 a. m.
July 28.....	78	26	42	Oil.	
Averages.—					
12 meals.....	66.6	55.5	70.6	No oil.	
4 meals.....	54	18.6	45	With oil.	

An inspection of the tables in this case shows that with the special meals the acidity was somewhat higher after the oil than after the control meals. The quantity recovered with oil is smaller than without.

The tests following daily meals show that with oil the quantity is somewhat decreased, while the acids are markedly lower than in control meals.

CASE 14.—Mr. H. Grand mal.

EXPERIMENT 1.—SPECIAL MEALS.

June 22, 1906.—Samples taken every 15 min. No seizures.

Time.	Quantity.	Free HCl.	Total acid.
7:30	Began eating.		
7:36	Finished eating.		
7:40	20 c.c.	4 c.c.	8 c.c.
7:55	22	25	30
8:05	15	36	44
8:15	15	38	50
8:46	10	..	..

June 23, 1906.—Samples fifteen minutes apart.

Time.	Quantity.	Free HCl.	Total acid.
7:39	Oil given.		
8:00	Began eating.		
8:05	Finished eating.		
8:06	15 c.c.	10 c.c.	22.5 c.c.
8:20	20	16	27
9:15	Stomach empty.		

June 28, 1906.—Samples every twenty minutes. No seizures.

Time.	Quantity.	Free HCl.	Total acid.
7:05	Oil given.		
7:40	Began eating.		
7:50	Finished eating.		
7:55	20 c.c.	4 c.c.	8 c.c.
8:15	22	7	15
8:32	22	9	20
8:55	15	9	20
9:15	19	13.3	30

EXPERIMENT 2.—DAILY HOURLY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Seizures.	
June 26.....	19 c.c.	55 c.c.	66 c.c.	None.	No oil before.
June 27.....	8	..	..	None.	Oil before.
July 3.....	160	24	36	None.	No oil before.
July 5.....	100	48	64	None.	No oil before.
July 6.....	5	20	30	None.	No oil before.
July 7.....	75	69	85	None.	No oil before.
July 9.....	75	60	72	G.M., 6:40 a.m.	No oil before.
July 19.....	200	48	62	None.	Oil before.
July 27.....	..	16	27	None.	Oil before.
July 28.....	10	..	..	None.	Oil before.
July 30.....	280	Tr.	12	None.	Oil before.
July 31.....	20	20	32	None.	No oil before.
August 1.....	155	22	32	None.	Oil before.
Averages.....	47.5	45.3	58	Without oil.	
	116	22.5	34	With oil before the meal.	

This patient had epileptic seizures as follows: June 22, grand mal at 5:50 a. m.; June 29, grand mal, 10:40 p. m.; July 9, grand mal at 6:40 a. m.; July 29, grand mal at 12:50 a. m. It is of interest to note that on the day following the last seizure free HCl was present only in traces.

SUMMARY.—Experiment 1.—No depression is seen from oil in the first oil meal. The stomach emptied itself very quickly. The second oil meal shows a delay in the appearance of acid, a decrease in the amount at the height of digestion, and a prolongation of the digestive period, the height of which was reached at its end.

It will be observed that the average acidity of the oil meals was lower while the quantity recovered was increased.

CASE 15.—Mr. R. C. P. Epilepsy of unknown cause. Attacks of grand mal and petit mal. At one time there was an aura consisting of a sensation of cold in the stomach and a quickening of the heart. No gastric symptoms.

EXPERIMENT 1.

June 18, 1906.—Shredded wheat biscuit meal.

Time.	Quantity.	Free HCl.	Total acid.
7:54	Began eating.		
7:59	Finished eating.		
8:00	15 c.c.	0 c.c.	8 c.c.
8:16	15	4.6	12
8:30	15	14	20
8:45	15	0	10
9:00	15	16	25
9:15	15	10	16

June 19, 1906.—Shredded wheat biscuit and oil.

Time.	Quantity.	Free HCl.	Total acid.
7:00	Oil taken.		
7:32	Began eating.		
7:38	Finished eating.		
7:40	15 c.c.	0 c.c.	2 c.c.
7:55	15	0	6
8:10	15	0	0
8:25	15	2	6
8:40	15	10	20

EXPERIMENT 2.

Daily meals of shredded wheat biscuit until June 25, inclusive; toast meals thereafter.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
June 20.....	90 c.c.	46.8 c.c.	58 c.c.	Control.	P.M., 1:20 p.m.
June 21.....	55	50	62	Control.	Mild, 2:40 a.m.
June 22.....	45	51	64	Control.	
June 23.....	12	51	64	Control.	
June 25.....	20	12	19	Control.	G., 10 p. m.
June 26.....	5	25	35	Control.	
July 3.....	190	8	16	Oil.	
July 5.....	40	30	40	Oil.	
July 6.....	80	56	66	Control.	
July 7.....	45	57	71	Control.	
July 9.....	35	25	44	Oil.	
July 10.....	..	17	35	Oil.	
July 26.....	148	11	20	Oil.	
July 27.....	58	31	41	Oil.	
July 28.....	2	10	20	Oil.	

Averages of 9 control meals: HCl, 39.8; total acid, 51; amount, 39.

Averages of 6 oil meals: HCl, 20.3; total acid, 32; amount, 94.

Chart 11, Case 15.—Experiment 2, heavy line, average total acid.

SUMMARY.

Experiment 1 shows what thus far seems to be the rule with the special meals, namely, a depression of the acidity by oil, a decrease in the rate of secretion, which continues at its height to the end of the digestive

period or reaches its highest point only at that time. The motility was unaffected by the oil.

Experiment 2.—Fifteen meals were given in this series, 9 without oil and 6 with oil. The secretion was distinctly depressed by the oil and the evacuation of the stomach lengthened.

CASE 16.—Mr. G. S. Grand mal.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
July 5.....	4 c.c.	20 c.c.	40 c.c.	Control.	
July 6.....	10	40	50	Control.	
July 7.....	5	17.5	30	Control.	
July 9.....	5	15	32.5	Control.	
July 10.....	10	22.5	32.5	Control.	
July 26.....	45	43.4	53.4	Control.	
July 27.....	8	0	..	Oil.	
July 28.....	10	5	10	Oil.	
July 30.....	8	10	20	Oil.	G. 1, a. m.
July 31.....	2	0	5	Control.	
August 1.....	9	14	20	Control.	
August 2.....	8	20	40	Oil.	G. 2, night.
August 3.....	8	Tr.	5	Oil.	
Averages.—					
Control.....	11.2	21.5	33		
Oil meals.....	8.4	7.0	19		

In this case attention should be called to the fact that up to the time of giving oil on the 27th, the lowest free HCl acidity was 15. The apparent effect of the oil was to reduce the secretion from 43.4 on the 26th to 0 on the 27th. On the 30th, following the administration of oil, the free acid was 10, while on the succeeding day without oil, its value was 0. On the next day free HCl reappeared and on August 2, notwithstanding the administration of oil, the record was a little higher.

Clinical and experimental experience tends to teach us that the effect of a dose of oil does not persist throughout the following day or even through the next meal. Its action seems to be limited to the period immediately following its administration.

When one considers these records the following questions arise:

(1) Was the low acidity found between July 27 and 30 dependent on nervous factors, and was its association with the administration of oil merely a coincidence?

(2) Was this low acidity, on the other hand, due to a true depressant action of the oil and were the low values of July 31 and August 1 the result of a persistence of one's depressing influence?

CASE 17.—Mr. L. R.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
July 5.....	15 c.c.	34 c.c.	46 c.c.	Control.	July 5, 1 p. m.
July 7.....	35	33	51	Control.	
July ?	40	37	54	Control.	
July 10.....	30	41	57	Control.	
July 26.....	8	53	63	Control.	July 25, 1 a. m.
July 27.....	28	15	25	Oil.	
July 28.....	155	4	12	Oil.	
July 30.....	170	10	18	Oil.	
July 31.....	12	23	33	Control.	
August 1.....	130	18	25	Oil.	
August 2.....	30	11	26	Oil.	Aug. 3, 1 a. m.
Averages.—					
No oil.....	23	37	50	All attacks petit mal.	
With oil.....	102	12	21	All attacks petit mal.	

CASE 18.—Mr. C. M.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
July 5.....	22 c.c.	40 c.c.	50 c.c.	Control.	
July 6.....	10	30	40	Control.	
July 7.....	120	48	65	Control.	
July 9.....	20	47	61	Control.	
July 10.....	145	37	51	Control.	
July 26.....	120	38	48	Control.	
July 27.....	50	30	50	Oil.	
July 28.....	240	0	6	Oil.	July 29, a. m.
July 30.....	..	29	41	Oil.	
July 31.....	75	40	54	Control.	July 31, a. m.
August 1.....	45	6	20	Oil.	
August 2.....	20	20	34	Oil.	
Averages.—					
No oil.....	40	51	71	Petit mal.	
With oil.....	17	30	90	Petit mal.	

In this series the control meals show free HCl values between 30 and 48, while the oil meals show a drop to below 30. The increase in the free HCl value on July 31 is of interest because oil did not precede the meal.

CASE 19.—Mr. F. K.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
July 5.....	10 c.c.	6 c.c.	8 c.c.	Control.	G., a. m.
July 6.....	5	30	40	Control.	P., a. m.
July 7.....	15	44	58	Control.	
July 9.....	100	40	52	Control.	
July 10.....	8	5	12	Control.	P., a. m.
July 25.....	..	..	..		P., 25, a. m.
July 26.....	120	51	66	Control.	2 P., 26, a. m.
July 27.....	35	32	46	Oil.	P., 27, a. m.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
July 28.....	40	0	10	Oil.	G., 28, a. m.
July 30.....	340	14	23	Oil.	
July 31.....	15	15	33	Control.	
August 1.....	80	58	70	Control.	
August 2.....	55	26	39	Oil.	P., a. m.
Averages.—					
No oil.....	44	31.0	85		2 G. mal.
With oil.....	107	18	29		6 P. mal.

CASE 20.—Mr. G. S.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
July 5.....	15 c.c.	24 c.c.	42 c.c.	Control.	
July 6.....	42	50	70	Control.	P., a. m.
July 7.....	10	11	23	Control.	P., July 7, a. m.
July —.....	30	26	45	Control.	P., July 8, a. m.
July 10.....	15	11.6	25	Control.	P., a. m.
July 25.....	..	..	..	..	P., July 25, a. m.
July 26.....	30	27	39	Control.	P., July 26, a. m.
July 27.....	50	10	23	Oil.	
July 28.....	50	0	4	Oil.	
July 30.....	50	31	41	Oil.	
July 31.....	90	32	45	Control.	
August 1.....	25	31	46	Control.	
August 2.....	110	7	16	Oil.	
Averages.—					
No oil.....	32	26.5	42		
With oil.....	65	12	21		

CASE 21.—Mr. B. C.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
July 6.....	55 c.c.	30 c.c.	40 c.c.	Control.	G. M.
July 7.....	120	19	38	Control.	
July 9.....	35	12	26	Control.	P. M.
July 10.....	75	21	39	Control.	
July 26.....	75	20	36	Control.	
July 27.....	100	6	20	Oil.	
July 28.....	60	14	26	Oil.	
July 30.....	200	6	18	Oil.	
July 31.....	115	22	34	Control.	
August 1.....	110	21	32	Oil.	
August 2.....	50	23	33	Oil.	
Averages.—					
No oil.....	79	21	35		
With oil.....	104	14	26		

CASE 22.—Mr. A. L. No seizures during experiment.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 6.....	90 c.c.	33 c.c.	49 c.c.	Control.
August 8.....	50	37	52	Control.
August 9.....	45	29	44	Control.
August 10.....	45	28	46	Oil.
August 11.....	..	40	58	Oil.
August 13.....	36	20	35	Oil.
August 14.....	100	27	34	Oil.
Averages.—				
No oil.....	61	30	48	
With oil.....	60	29	46	

CASE 23.—Mr. H. Y. No seizures during experiment.

SUMMARY OF DAILY MEALS.

August 4	80 c.c.	23 c.c.	33 c.c.	Control.
August 6	30	36	47	Control.
August 7	30	34	45	Control.
August 8	25	32	43	Control.
August 9	72	9	16	Oil.
August 10	50	30	50	Oil.
August 11	170	10	23	Oil.
August 13	55	37	48	Oil.
Averages.—				
With oil	87	21	34	
No oil	41	31	42	

CASE 24.—Mr. R. W.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
August 4	8 c.c.	15 c.c.	25 c.c.	Control.	G. M., a. m.
August 6	23	36.4	48	Control.	G. M., a. m.
August 7	60	60	78	Control.	G. M., a. m.
August 8	12	30	50	Control.	
August 9	12	6	20	Oil.	
August 10	15	20	36	Oil.	
August 11	20	20	37.5	Oil.	
August 12	..	..	..	..	G.M., Aug. 12, a.m.
August 13	10	17.5	32.5	Oil.	
August 14	..	..	..	..	G.M., Aug. 14, a.m.
Averages.—					
No oil	26	35.3	50		
With oil	14	16	31.5		

CASE 25.—Mr. W. C.

Date.	Quantity.	Free HCl.	Total acid.	Oil.	Seizures.
August 4	50 c.c.	19 c.c.	42 c.c.	Control.	
August 6	55	31	50	Control.	
August 7	22	20	34	Control.	2 G. M., a. m.*
August 8	50	18	32	Control.	
August 9	35	11	23	Control.	
August 10	45	8	24	Oil.	2 p. m.
August 11	35	33	47	Oil.	
August 13	115	15	32	Oil.	
August 14	70	40	54	Oil.	
August 15	..	..	..	..	Aug. 15, 2 p. m.
Averages.—					
With oil	66	24	39		
No oil	42	20	36		

NOTE.—This case shows little change in the acidity, while after the administration of oil the evacuation is delayed.

CASE 26.—J. E. No. 1992. No seizures during experiment.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 4	115 c.c.	34 c.c.	48 c.c.	Control.
August 6	30	16	35	Control.
August 7	95	34	55	Control.
August 8	4	15	30	Control.
August 9	12	14	32	Control.
August 10	12	22	38	Control.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 11.....	12	10	27.5	Control.
August 12.....	15	?	20	Control.
August 14.....	105	23	41	Oil.
August 15.....	74	16	36	Oil.
August 16.....	170	30	48	Oil.
August 17.....	45	28	44	Oil.
August 18.....	22	19	37	Oil.
Averages.—				
No oil.....	37	19	35.6	
With oil.....	83	23	41	

CASE 27.—R. B. No. 1045. No seizures during experiment.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 4.....	15 c.c.	8 c.c.	17 c.c.	Control.
August 6.....	15	30	50	Control.
August 7.....	10	16	27	Control.
August 8.....	5	20	37.5	Control.
August 9.....	8	30	50	Control.
August 10.....	40	32	52	Oil.
August 11.....	50	18	43	Oil.
August 13.....	42	15	30	Oil.
August 14.....	94	20	38	Oil.
Averages.—				
No oil.....	11	21	36	
With oil.....	56	21	41	

The oil had apparently no effect in this case except to decrease the motility.

CASE 28.—H. S. No. 885. No seizures during experiment.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 5.....	12 c.c.	40 c.c.	51 c.c.	Control.
August 6.....	0	..	..	Control.
August 7.....	20	38	50	Control.
August 8.....	10	31	41	Control.
August 9.....	10	10	16.6	Oil.
August 11.....	125	10	35	Oil.
August 13.....	15	0	5	Oil.
Averages.—				
No oil.....	14	36.3	47	
With oil.....	50	6	18.7	

CASE 29.—W. H. No. 1278. No seizures during experiment.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 4.....	40 c.c.	20 c.c.	32 c.c.	Control.
August 6.....	80	24	40	Control.
August 7.....	45	31	47	Control.
August 8.....	35	30	43	Control.
August 9.....	55	17	31	Oil.
August 10.....	290	9	22	Oil.
August 11.....	70	18	32	Oil.
August 13.....	25	41	50	Oil.
Averages.—				
With oil.....	110	21	36	
No oil.....	50	29	40.5	

CASE 30.—W. M. No. 1096. No seizures.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 6.....	20 c.c.	32 c.c.	54 c.c.	Control.
August 7.....	12	14	22	Control.
August 8.....	12	35	53	Control.
August 9.....	12	42	57	Control.
August 10.....	115	20	40	Oil.
August 11.....	165	20	33	Oil.
August 13.....	14	20	35	Oil.
Averages.—				
No oil.....	14	29.5	46.5	
With oil.....	98	20	35	

CASE 31.—F. K. No. 1889. No seizures.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 4.....	28 c.c.	14 c.c.	29 c.c.	Control.
August 6.....	18	23	42	Control.
August 7.....	95	32	50	Control.
August 8.....	8	18	26	Control.
August 9.....	10	25	40	Control.
August 10.....	240	8	22	Oil.
August 11.....	290	13	27	Oil.
August 13.....	170	29	42	Oil.
August 14.....	35	16	20	Oil.
August 15.....	98	49	62	Oil.
August 16.....	135	42	54	Oil.
Averages.—				
With oil.....	161	26	38	
No oil.....	32	22.4	37	

CASE 32.—J. W.

SUMMARY OF DAILY MEALS.

Date.	Quantity.	Free HCl.	Total acid.	Oil.
August 6.....	5 c.c.	15 c.c.	30 c.c.	Control.
August 7.....	8	32	40	Control.
August 9.....	18	17.5	35	Control.
August 10.....	72	40	56	Control.
August 11.....	12	20	35	Control.
August 13.....	12	0	15	Control.
August 14.....	18	6	18	Oil.
August 15.....	42	17	28	Oil.
August 16.....	50	12	23	Oil.
August 17.....	82	9	23	Oil.
August 18.....	40	0	..	Oil.
Averages.—				
No oil.....	21	24.9	29.2	
With oil.....	48.4	10	33	

CASE 33.—Mr. A. K. (This case was overlooked and is not included in the summaries.)

EXPERIMENT 1.

June 20, 1906.

Time.	Quantity.	Free HCl.	Total acid.
7:45	Began eating.		
7:50	Finished eating.		
7:52	15 c.c.	2 c.c.	6 c.c.
8:05	15	16	26
8:24	20	25	36
8:48	16	43	58

Chart 12, Case 33.—A. K.

EXPERIMENT 2.

June 21, 1906.

Time.	Quantity.	Free HCl.	Total acid.
7:00	Oil taken.		
7:30	Began eating.		
7:36	Finished eating.		
7:40	15 c.c.	2 c.c.	6 c.c.
7:55	20	5	12
8:10	15	5.4	17.4
8:25	15	0	20
8:50	15	6	12
9:05	20	4	22

A marked lowering of the acidity will be observed in the meal preceded by oil. On the next day, in 70 minutes, the free acid was 71 and the total acidity 87; on the 23d, 42 and 51. The diminution was therefore exactly coincident with the administration of oil.

The cases reported in the epileptic series were observed wholly by Dr. Munson. In connection with these cases, there were factors, the consideration of which will be taken up by him in a separate paper. The patients were all taking the bromid treatment, and, as this was a constant factor, we may assume that the effect, whatever it may have been, was constant. From a consideration of this series it would seem that an epileptic seizure does not exercise any definite influence on the gastric

secretion. At times a lowering of the acid values is observed before the seizure, while again a similar condition may follow the attack. When the cases of this series are taken collectively and considered critically, they are seen, for the greater part, to follow closely the rules established by the University Hospital cases.

The following table, comprising 310 stomach analyses of the daily meal series, has been compiled for the purpose of showing the average quantity and acidities of control meals, without oil, compared with meals preceded half an hour by oil:

TABLE 1.

Case. No.	Number of Meals.		Quantity.		Free HCl.		Total acid.	
	Control.	Oil.	Control.	Oil.	Control.	Oil.	Control.	Oil.
5	15	9	40	158	51	21	65	34
6	8	5	74	199	62.5	25.7	73	41
7	9	16	64	106	49	40.5	66.2	55
8	12	9	84	105	91	55.5	104.9	62.2
10	7	5	100	67	59	60.8	71	75
12	7	5	64	92	20.7	14	28	28
13	12	4	66	54	55.5	18.6	70.6	45
14	7	6	47.5	116	45.3	22.5	58	34
15	8	7	44	67.5	43.6	18.8	53.8	30.8
16	8	5	11.2	8.4	21.5	7	33	19
17	6	5	23	102	37	12	50	21
18	7	5	71	90	40	17	51	30
19	8	4	44	107	31	18	85	29
20	8	4	32	65	26	12	42	21
21	6	5	79	104	21	14	35	26
22	3	4	61	60	30	29	48	46
23	4	4	41	87	31	21	42	34
24	4	4	26	14	35.3	16	50	31
25	5	4	42	66	20	24	36	39
26	8	5	37	83	19	23	35.6	41
27	5	4	56	11	21	21	41	36
28	4	3	14	50	36	6	47	18.7
29	4	4	50	110	29	21	40.5	36
30	4	3	14	98	29.5	20	46.5	35
31	5	6	32	161	22.4	26	37	38
32	6	5	21	46.4	20.6	8.8	35	18.4
Averages of all meals.....			43.3	85.6	36.4	22.4	51.3	35.5

From the compilation of the averages of these 26 cases the following observations may be made:

(a) The motility was decreased in 18 cases,⁹ increased in 5 cases,⁸ unchanged in 3 cases.¹⁰

8. Cases 10, 18, 16, 24, 27.

9. Cases 5, 6, 12, 14, 15, 17, 18, 19, 20, 21, 23, 25, 26, 28, 30, 31, 32.

10. Case 22.

(b) The free acid was decreased in 19 cases,¹¹ increased in 0 cases, unchanged in 6 cases.¹²

(c) The total acidity was increased in 17 cases,¹³ increased in 0 cases, unchanged in 8 cases.¹⁴

A true estimate of the action of oil on the gastric functions may be obtained by comparing the following averages of the 170 control meals with the 140 meals preceded by oil, for in these individual characteristics and modifying circumstances will be eliminated almost completely.

	Quantity.	Free HCl.	Total Acidity.
Controls	43.3	36.4	51.3
Oil meals	85.6	22.04	35.5

For this series of 310 meals, withdrawn one hour from the beginning of ingestion, it may be concluded that the administration of two ounces of oil, half an hour before the meal, delays the evacuation of the stomach and decreases the acidity markedly.

TABLE 2.

Case No.	No. of meal.	Beginning of secretion in the oil meals.	Free acid value of oil meal after 1 hr., compared with control.	Height of secretion reached in the		Ultimate height of secretion with the oil meals compared with controls.	End of secretion reached with	
				Control in min.	Oil meal in min.		Control in min.	Oil meal in min.
5	1	Delayed 10 min.	Decreased.	65	70	Lower.	85	90
	2	Unchanged.	Decreased.	65	85	Lower.	85	95
6	3	Delayed 10 min.	Decreased.	45	140	Higher.	75	140
9	4	Unchanged.	Same.	50	40	Same.	60	65
	5	Hastened.	Increased.	50	30	Higher.	60	70
10	6	Hastened.	Decreased.	85	95	Higher.	115	115
	7	Unchanged.	Increased.	79	78	Higher.	136	111
	8	Unchanged.				Higher.	110	113
12	9	Unchanged.	Increased.	85	83	Lower.	100	120
13	10	Unchanged.	Increased.	80	80	Higher.	155	150
14	11	Increased.	Increased.	125	55	Lower.	76	75
	12	Delayed 5 min.	Decreased.	45	20	Lower.	76	95
15	13	Delayed 31 min.	Decreased.	45	95	Same.	83	68
33	14	Delayed 5 min.	Decreased.	66	68	Lower.	63	95
			Decreased.	63	80			
		5 delayed.	8 decr.	4 hastened.		6 lower.	8 prolonged.	
Averages		3 hastened.	5 iner.	7 prolonged.		6 higher.	2 shortened.	
		6 unchanged.	1 same.	3 unchanged.		2 same.	4 unch'ng'd.	

In the special meal series a few additional points are demonstrated. An interpretation of the action of oil in producing the above effects is

11. Cases 5, 6, 7, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 28, 29, 30, 32.

12. Cases 10, 22, 25, 26, 27, 31.

13. Cases 5, 6, 7, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 28, 30, 32.

14. Cases 10, 12, 22, 25, 26, 27, 29, 31.

obtained. By referring to Table 2 and the acidity curves, it will be observed (1) that of the fourteen meals eight showed decreased acid values at the end of an hour, the decrease being marked in most cases and corresponding with the change noted in the daily meal series; (2) that in some cases the acidity reached its height earlier with the oil meals, but that in half of the cases the height of the secretion with the oil meals is markedly delayed as compared with the controls; (3) that the secretion period, or the period of digestion, is distinctly prolonged in eight of the fourteen meals.

There are many factors associated with experiments of this character which render it almost impossible to duplicate at all times the observations on the phenomena of digestion which may be made on dogs with isolated miniature stomachs. The psychic effects are altogether of an opposing nature, and the method of experimentation of necessity is radically inferior. The dog knows nothing about his miniature stomach and has only the most pleasurable psychic influences during his feeding, digestion and subsequent experimentation. In our cases the knowledge of experimentation and the discomfort caused by the presence of the tube in the stomach, or by its frequent passing, are constantly present. Under such conditions there are certainly no appetizing influences at work and consequently little or no psychic juice, which seems to figure so largely in Pawlow's experiments, is secreted.

When, under ideal conditions, the administration of oil to dogs with miniature stomachs brings about lowered acidity values, delay of the height of digestion, lengthening of the digestive period and lowering of motility, and when experiments on the human stomach are followed, in a large proportion of cases, by results which closely simulate other dogs, it would seem only logical to conclude that the conditions observed in the dog's stomach are closely analogous to those which occur under similar conditions in the human being.

Such results as were obtained in Case 6 and Case 9 are influenced by a factor which in the one case (6) was not always at work, while in the other (9) it was constant, namely, the factor of hypersecretion. In the former case our examinations showed intermittent hypersecretion; in the latter continual hypersecretion, for in this case the fasting stomach always contained a strongly active gastric juice.

Our experiments show that, when once the secretion is induced, its progress is not easily influenced by oil. At times, in hypersecretion, even though the precaution be taken to wash and drain the stomach, only a few seconds will suffice to enable one to collect a sample of gastric juice of decided peptic value (Case 6). If, on the other hand, the fasting stomach contains no gastric juice and oil be introduced, the characteristic

group of digestive phenomena are almost invariably observed, namely, delayed secretion, retardation of the appearance of the height of digestion, prolongation of the digestive period.

DISCUSSION.

We have definitely confirmed the observations of others and proved that oil produces a certain group of gastric phenomena which are spoken of as depressant. The question as to how this is brought about appears to us to have been unsettled up to the present time. As cited in our introductory remarks, Pawlow maintains that the influence of fats and oils is exercised through reflex central stimulation of the inhibitory nerves of the glands or the inhibitory centers of these nerves; that it is not the result of their purely mechanical action in covering the mucous membrane and preventing excitation of the nerve endings. Later he admits that the mechanical effect has not yet been satisfactorily shown. Pawlow's experiments are conclusive that oil does have a central inhibitory action. But, we think, the purely mechanical effect of oil plays a great, if not as great, a part in lowering the acidity of peptic digestion.

It has long been known that certain kinds of food remain in the stomach longer than others, and that the evacuation of the stomach, as well as its secretion, is subject to food stimulation. If food, coated with oil, cannot stimulate the gastric nerve endings, no juice will flow until, by mechanical effect, the oil is removed from certain portions of the food. We may then consider that oil acts mechanically in two ways: (1) by covering the food; and (2) by covering the mucosa. We bring forward two experiments which seem to sustain these views. If three pieces of coagulated egg albumin of the same size be immersed for a few minutes in water, glycerin and olive oil, respectively, and then placed separately in tubes containing equal amounts of stomach fluid and incubated at body temperature, it will be observed that by the time the control has been completely dissolved, which occurs with comparative rapidity, the glycerinized piece is about one-half digested, while the piece immersed in oil is only beginning to show the slightest change around the edges. It is quite apparent from this experiment that oil interferes with digestion by coating the food and mechanically preventing the digestive juices from attacking it.

The fact that oil, given immediately before or after a test meal, does not bring about so marked a lowering of the secretions as when it is given half an hour before, leads one to believe that there are more than reflex central inhibitory influences at work. Food stimulation, as well as psychic stimulation of nervous mechanisms, is usually more

promptly induced. Two ounces of olive oil administered ten minutes before a meal depresses the secretion more than does one ounce, but not as much as when it is given thirty minutes before the meal.

To see if this mechanical phenomenon could be shown graphically, the following experiment was conducted in the Radiographic Department of the University Hospital. Our thanks are due Mr. Vernon J. Willey, director of the laboratory, for giving freely of his time, and for the excellent radiographs made.

Two ounces of olive oil, intimately mixed with one ounce of bismuth subnitrate, were given to a very thin patient with slight gastrop-tosis. The patient was strapped to a plate and two minutes after swallowing the mixture an exposure was made. Another plate was exposed at ten minutes, another at fifteen, and still another at twenty-five minutes. In the first plate the oil and bismuth appears as a roundish or oval mass lying at the bottom of the stomach. As the time progressed an increase in the area of coating occurred, until at twenty-five minutes the entire stomach was coated.

From this experiment, particularly when taken in conjunction with Case 8 and the preceding experiment, it can be asserted that olive oil delays the secretion of the gastric juice to a considerable extent, at least by mechanically coating the walls of the stomach.

Taking all facts into consideration, the following conclusions appear to be justified:

1. Oil depresses the secretions of the stomach by reflex central action.
2. The reflex action is unlike that of ordinary food stimulation in that it is slower.
3. The reflex central action is a quantitative one, the depression becoming greater as the amount of oil administered is increased.
4. Oil depresses the secretion of the gastric glands by mechanical inhibition of food stimulation: (a) by coating the food; (b) by coating the stomach wall.
5. In proportion to the rapidity with which the walls of the stomach are covered with oil, the inhibition of secretion occurs, from nervous as well as from mechanical influences.

Our experiments lead us to the opinion that the characteristic group of phenomena which follow the administration of olive and cotton seed oil are due to mechanical action as well as to reflex, central, inhibitory stimulation.

Much knowledge can be obtained from experiments of this character. Such experiments, though laborious and beset with numerous factors of error, are entirely feasible. Although the results compare closely with

those acquired by animal experimentation, still it would seem advisable to proceed along some such line as this and investigate the action of all food stuffs, as well as of such drugs as are supposed to influence gastric secretion. A trustworthy control and a suitable subject are the all-important requirements. In the University Hospital cases hyperchlorhydria was present. In the Craig Colony cases the secretions were for the greater part within what we call the normal limits. Normal cases would probably form a more ideal basis of investigation from a purely experimental point of view.

CONCLUSIONS.

1. Olive oil and cotton seed oil, when given in connection with the usual test breakfast, decrease the gastric acidity at the end of the hour and retard the evacuation of the stomach.

2. The beginning of the secretion of hydrochloric acid is delayed when oil precedes the meal, unchanged when oil follows the meal.

3. The height of digestion is delayed when oil is given either before or after the meal.

4. The height of secretion is lowered when oil precedes the meal, unchanged when oil follows the meal.

5. If the progress of digestion is watched by the removal of small samples of stomach fluid at frequent intervals it will be observed, when oil precedes the meal by one-half hour, that at the end of what is usually taken as the digestive period for a test breakfast (three-fourths to one hour) the acidity is distinctly lower, while as great a height as is present in the control meal is frequently reached some minutes later.

6. The action of oil on the stomach functions is only a temporary one. It has no effect on subsequent meals unaccompanied by oil.

7. The therapeutic value of oil is apparent. In *suitable* cases it is preferable to antacids because of its caloric value. In hyperchlorhydria it should precede the meal. In hypochlorhydria it should follow the meal. In stasis and persistent slow evacuation it should be eschewed. In hypermotility it may be given before, during or after the meal.

8. Oil lowers the gastric secretion both by reflex central inhibitory stimulation and by mechanical action.

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