from the depressor curve. This matter is of great interest because it justifies the hope that a therapy of the vasomotor cells may later be established.

The individual action of peripheral areas is being studied by the writer and Dr. F. H. Pratt.¹⁰ We have thus far busied ourselves with the effect on peripheral areas of impulses derived from the blood vessels themselves. An artificial circulation is established through the hind limb of a cat and the flow measured by a counter which records the drops flowing out of the femoral vein. All connection between the blood vessels in the limb and those in the body is shut off. If the carotid artery be now opened, the general blood pressure will fall sharply. The vessels of the isolated limb will then constrict. If the general blood pressure be sharply raised, the vessels in the isolated limb will dilate. Thus variations in the general blood pressure give rise to a protective reflex, tending to raise the blood pressure when it has fallen, and to lower it when too high.

The more the circulation is studied, the stronger is the conviction that it is not a fixed state, but a sensitive equilibrium, the result of the constantly varying action of a great number of factors. Hence the difficulty of the subject and the necessity of separating the complicated mass problems into simpler problems, capable of answer one by one. Such a separation can be accomplished only in the laboratory, and it is to experimentation upon animals that we must chiefly look for new knowledge in this field.

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- ³ W. T. Porter: *Am. Jour. Physiol.*, 1907, xx, p. 401.
- ⁴ These figures may be changed slightly by the addition of new material.
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- ⁸ Reported to the American Physiological Society, in January, 1908.
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- ¹⁰ It is probable that the brachial nerve will be found to be like the sciatic nerve when the number of observations is increased.
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- ¹² G. W. Crile: *The blood pressure in surgery*, 1903.
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Original Articles.

THE CLINICAL IMPORTANCE OF THE UNEVEN DISTRIBUTION OF HYDROCHLORIC ACID IN THE GASTRIC CONTENTS.

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UNTIL recently one assumption has underlain all the quantitative work done on the gastric contents. A test meal of one sort or another was given, and after a definite interval of time had elapsed, a sufficient quantity was withdrawn, and,

among other things, the total acidity and the free hydrochloric acid determined. The assumption that underlies all these methods is that the chyme so obtained offers in every respect a fair sample of the total stomach contents. Certain methods in particular depend fundamentally upon this assumption. This is the case, for instance, with the method of Matthieu and Remond¹ for determining the total quantity of the gastric contents. The contents, so far as possible, are withdrawn. Thereupon 400 cc. of distilled water are introduced into the stomach, intimately mixed with what remains and again withdrawn. A comparison of the acidity of the original chyme with that so diluted will give us, by a simple calculation, the total quantity of gastric contents, but obviously only if the portion remaining in the stomach has the same acidity as that first expressed. Sahli's² otherwise very ingenious utilization of the fat remaining in the stomach after the ingestion of a flour and butter soup, since it involves the use of Matthieu and Remond's method, is based upon the same assumption. The same is true of Strauss's specific gravity method. Practically all the textbooks are silent upon this point. Even Boas³ in the English 1907 edition of his work on "Diseases of the Stomach" fails to mention this possible source of error.

This is the less excusable since, within the last few years, some very important work has been done on the lack of homogeneity of the gastric contents. Some twenty years ago Ellenberger⁴ and his pupils showed that when horses were fed first hay and then oats, these two substances, instead of being intimately mingled in the stomach, remained separate, in distinct layers, nearly to the end of gastric digestion. Similar results were obtained with dogs and pigs and seemed definitely to disprove the existence of homogeneous stomach contents, at least in these animals. Unfortunately these observations were ignored for many years, both by physiologists and by clinicians; perhaps because they appeared chiefly in veterinary journals. They have recently been amply confirmed by Scheunert⁵ and especially by Grutzner.⁶ The latter fed various animals (frogs, rats, rabbits, dogs, etc.) with food, the successive portions of which were of different colors. At varying intervals the stomachs were tied off, removed and plunged into a salt and ice mixture. The mushy contents, frozen solid and cut into sections, showed always a definite stratification. The different portions of the food, far from being intimately mingled, could be seen in layers, separate and distinct, one above the other.

All of these experiments were done with solid food. It might be thought that a liquid meal would result in greater homogeneity of the gastric contents. Prym⁷ has investigated the behavior of Sahli's flour and butter soup in this respect. Dogs were given such soup, to which blue litmus had been added. At varying intervals the stomachs were tied off, cut out, frozen solid and cut into sections. The central portion and that near the cardia were usually found still blue in color, the rest having been turned red by the

hydrochloric acid. Different portions of these contents were cut out, thawed and their acidity determined. It appeared that the degree of acidity was greater at the periphery of the mass than at the center, and decreased from the fundus toward the pyloric end. All of these observations show that the different portions of the gastric contents not only do not represent a homogeneous mixture of the food taken, but that they contain various amounts of the hydrochloric acid secreted by the mucosa.

It is clear, however, that these results cannot without verification be applied to human beings. Prym administered Sahli test meals to a number of patients, and expressed the stomach contents through a double tube with one opening at the tip, the other 10 cm. higher up. In this way he was able to get gastric contents simultaneously from different parts of the stomach, and found that the two portions varied widely in acidity. Still more beautiful work along these lines was done by Sick.⁸ He used a stomach tube, ingeniously constructed, which enabled him at will to obtain gastric contents from fundus or pyloric portion. He found that in man, after a Sahli test meal, the acidity of the pyloric gastric contents was very much less than that of the fundal portion, and that, therefore, even after a liquid meal, the stomach contents are far from homogeneous. This need not surprise us, since Edlefsen⁹ found that, in the bladder, the lower portions of the urine are often denser than the upper, so that the first portion of urine passed has a higher specific gravity than the last.

It would seem, then, that the notions, generally accepted, of the processes that take place during gastric digestion require considerable modification. The observations referred to, together with those of Cannon and others, indicate that what happens is somewhat as follows. The fundus of the stomach plays the double part on a receiving and a secreting organ. During digestion its lumen is separated more or less completely from that of the pyloric portion by a definite constriction dividing the stomach into two unequal parts, and offering considerable resistance to the free interchange of contents. The food as it is swallowed is received into the fundus, successive portions lying one above or in part within the preceding ones. The gastric juice does not entirely penetrate the semi-solid food mass, but attacks chiefly that portion which lies in contact with the mucous membrane. This portion becomes digested and liquefied and is transported to the pyloric portion, where the process is completed. Meanwhile the interior of the mass remains alkaline and continues to undergo amylolytic digestion under the influence of the swallowed saliva until the removal of the peripheral portion exposes the more central parts in their turn to the action of the gastric juice. The degree of acidity of different portions of the gastric contents must, therefore, vary widely. The peripheral portion of the fundal contents, since it consists of nearly pure gastric secretion, is most strongly acid, the pyloric contents are less so, while the interior of the food

mass in the fundus becomes acid last of all. Incidentally, these observations explain how salivary and peptic digestion can go on simultaneously in the stomach.

In spite of all this, one might suppose that even though the undisturbed chyme be not homogeneous, the violent retching attendant upon the use of the stomach tube in ordinary clinical work may cause such an intermingling of the stomach contents as to obviate this objection in practical work. That this is not always the case was shown by Bardenstein.¹⁰ He obtained the gastric contents in thirteen cases, first by means of expression, and then was able to obtain an additional quantity by means of aspiration. These two portions varied considerably in their degree of acidity, the first portion being the more strongly acid of the two, four times, and the less strongly acid, nine times. He concluded that in all gastric work the aspirator should be used, as only so could the total contents be obtained. He believed, however, that if this precaution were observed, the results obtained would be trustworthy. This last assumption seemed to us sufficiently ill founded to justify us in carrying his observations one step farther. We desired to ascertain whether it was possible by means of the ordinary methods of expression and aspiration to obtain the gastric contents with a reasonable degree of completeness, and if this were not the case, to determine whether, in spite of the intermingling of stomach contents due to retching and the like, the portion remaining in the stomach differed in acidity from the portion obtained sufficiently to introduce a serious error. The following procedure was adopted. Having satisfied ourselves that the stomach was empty, the patient was given a test meal. After a proper interval a stomach tube was introduced, with the patient sitting on a table or couch, and the contents aspirated into a bottle in the usual manner. In addition, the patient was made to retch, the tube was moved up and down, and every effort was made to obtain all the contents possible. The tube was then disconnected from the flask, the patient was made to lie first on his back, then on his right side, and the contents obtainable in this position, by expression or aspiration, collected. It was usually found that after the stomach had apparently been emptied, it was possible, by inflating it, to obtain considerable gastric contents with the escaping air. Finally, in a number of cases, the stomach was washed with a measured quantity of distilled water in order to determine approximately, according to Matthieu and Remond, the amount of gastric contents absolutely unobtainable. This method, in spite of its fundamental inaccuracy, could be used for our purpose, since, as will appear below, the contents remaining in the stomach are probably usually of a lower degree of acidity than those expressed. Hence the results obtained by the method of Matthieu and Remond will usually be too low, and we may conclude that the amount of stomach contents not removable is at least as great as that calculated by this method.

Our observations show conclusively that it is impossible even approximately to empty the stomach by means of expression and aspiration with the patient sitting upright. In some 65 cases so studied we found that after the stomach had been emptied as completely as possible in this position, it was nearly always possible to obtain considerable additional gastric contents when the patient was made to lie down. Indeed, in nearly a third of our cases, the amount so obtained exceeded that previously aspirated in the erect posture, while the method of Matthieu and Remond indicated an unobtainable residue of from 20 to 80 cc. This will be best illustrated by a short table of our last ten cases, in which particular pains were taken to empty the stomach both by expression and aspiration, first in the erect and then in the prone posture.

Patient.	Diagnosis.	Unobtainable residue (calculated).		
		Erect. cc.	Prone. cc.	cc.
Mrs. H.	Gastroptosis,	35	26	25
T. H.	Neurasthenia,	24	34	42
Mrs. F.	Hyperacidity,	23	17	49
H. D.	Pylorospasm,	150	30	64
H. D.	Pylorospasm,	200	30	23
Mrs. A.	Gastroptosis,	120	20	11
A. H.	Achylia,	17	34	?
Mrs. A.	Gastroptosis,	15	65	19
R. H.	Mucous colitis,	10	40	45
Mrs. Q.	Chronic gastritis,	30	25	63

It being clear that the usual methods of expression and aspiration furnish us with only a comparatively small portion of the entire gastric contents, it becomes important to learn whether this portion corresponds fairly well in its degree of acidity with that left in the stomach. We determined this by first obtaining all the contents possible in the erect posture, and then expressing a portion of the remainder, after inflating the stomach with air, the patient lying prone, or nearly so. The acidity of these two portions was then determined and compared. Some 28 patients were so examined one hour after taking an Ewald-Boas breakfast, consisting of 35 gm. of toast and 400 cc. of water. In these 28 cases the acidity of the two portions was in fairly good agreement 11 times; the first portion was decidedly more acid than the second 14 times, the reverse being true 3 times. Sometimes the difference was excessive. Thus in a case of suspected gastric ulcer the first portion of 65 cc. had a total acidity of 103.5* with free HCl, 76.5, while the second portion of 50 cc. had a total acidity of 52 with free acid, 26. The unobtainable residue in this case was calculated as 62 cc., and there was no telling how the acidity of this last, if ascertainable, might have modified the picture. It is clear, however, that the examination of the first portion, the only portion ordinarily obtained for examination, gave a very exaggerated notion of the degree of hyperacidity of the entire gastric contents. Conversely, in a case of *tabes dorsalis*, the first portion had a total acidity of 29,

free HCl, 20; whereas the second portion showed total acidity 65, free HCl, 40. Here the portion ordinarily obtained gave an entirely false impression of marked subacidity. Cases similar, though not quite so marked, were frequently observed.

Three hours after a Riegel dinner the acidity of the two portions was more frequently fairly uniform, as might be expected from the longer period of time during which the contents remained in the stomach. Occasionally, however, marked differences were observed, as in the following case of constipation: first portion, 20 cc. obtained; total acidity, 76; free HCl, 37; second portion, 35 cc. obtained; total acidity, 108; free HCl, 44. The unobtainable residue was not calculated.

It was hoped that a liquid test meal, such as Sahli's flour and butter soup, would give more uniform results. To a certain extent this proved to be the case. Only eight patients were so examined. In five the acidity of the two portions differed by less than 5, but in the other three the differences were more considerable, being 7.5, 12.5 and 16.5, respectively. The unobtainable residue varied from 44 to 100 cc.

Split pea soup (four cases) gave even more divergent results, the first portion usually being decidedly more acid than the second. The differences in total acidity varied from 10 to 31, the free HCl showing a corresponding difference.

Finally, it was thought worth while to test the behavior of a more perfectly fluid test meal. The patients were given 500 cc. of beef tea, warmed, into which the whites of two eggs were stirred. The whole, when properly salted, was palatable and formed an adequate stimulus to the gastric mucosa. The contents were obtained in two portions as before, one hour after the meal had been eaten. Twelve cases were so examined. The total acidity varied from 13 to 105.5, and the free HCl from 0 to 81.5. In 10 of our 12 cases, the two portions agreed nearly or quite exactly, both in total acidity and in free HCl. In the two cases that showed some variation in the acidity of the two portions, the differences were only 3.5 and 4, respectively, differences that are of no practical diagnostic importance. Unfortunately, the degree of acidity of the beef tea itself is so considerable as to rob the results obtained by its use as a test meal of much of their significance. Moreover, its perfect fluidity renders it an inadequate test of gastric motility.

Finally, in a number of cases of pyloric obstruction, the gastric contents were removed in two portions, as above, before breakfast. Their acidities always coincided accurately. This was to have been expected, since the twelve hours or more during which the contents had remained in the stomach gave ample time for equable intermixture of the stomach contents.

In the great bulk of our cases, the first portion obtained was more strongly acid than the second. Since Prym has shown for animals and Sick for man that the gastric content in the fundal portion as a whole has a higher degree of acidity than that in the pyloric portion, it would seem probable

* The number used to express the acidity refers to the number of cubic centimeters of N/10 NaOH solution required to neutralize 100 cc. of gastric contents.

that the eye of our stomach tube usually lay in the fundus, and that first the fundal and then the pyloric portion was aspirated. This is made still more probable by the observation that the free HCl in the first portion exceeded that in the second even more than the total acidity of the first did that of the second, an observation fully accounted for by the more advanced stage of digestion near the pylorus.

Our conclusions may be briefly summarized as follows:

1. When the stomach contents are expressed and aspirated in the usual manner as completely as possible, the patient sitting erect, only a comparatively small portion of the gastric contents can be obtained.
2. After any of the usual test-meals the acidity of the portion so obtained cannot be assumed to represent the acidity of the stomach contents as a whole.
3. If, after this portion of the stomach contents has been removed, the patient is made to lie down, it is usually possible, by means of aspiration, inflation and the like, to obtain a further considerable quantity of stomach contents. This second portion often differs considerably in its acidity from the first portion.
4. Even after this second portion has been removed, the stomach still contains considerable unobtainable residue. The amount of this is apparently independent of the total quantity of gastric contents, and probably varies from 1 to 3 oz. Of its degree of acidity we can know nothing; certainly we have no ground for the assumption that it is identical with the acidity of the contents obtained for examination.
5. The quantitative determination of the acidity of the gastric contents is thus seen to be subject to a grave source of error. This will be diminished if the contents obtainable in the prone position are also examined. It will be further lessened if the acidity of the two portions does not differ very widely, since then we may assume that the acidity of the unobtainable residue will itself not be very different.
6. It follows that, in practice, trustworthy results can be obtained only if the following precautions are observed: the stomach contents must be obtained separately in the erect and in the prone posture; the acidity of each portion must be determined and diagnostic conclusions, based upon the degree of acidity, can be drawn only if the two acidities correspond fairly well, or if the total quantity of gastric contents obtained is so great that the unknown acidity of the unobtainable residue may be neglected.
7. Indeed, the entire concept of degree of acidity of the stomach contents seems not to correspond to anything real. Different portions of the stomach contents have different degrees of acidity. We may speak of the acidity of the contents at the fundus or near the pylorus, or, at most, of the average acidity of the total contents. It is this last that clinicians have attempted to determine, with what scanty success it has been the object of this paper to show.

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AN INTRACANALICULAR PAPILLARY ADENOFIBROMA FROM THE GROIN.

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THIS case, from the Pathological Laboratory of the Harvard Medical School, No. 2297, was given me for study by Dr. S. B. Wolbach. The tumor itself was removed by Dr. P. P. Johnson, of Beverly, Mass., to whom I am indebted for the clinical data and for permission to publish the case.

A papillary adeno-fibroma is so rarely seen outside the region of the breasts that one situated so far away as the groin is of considerable interest. Especially is this true if we consider the tumor in the light of its possible relation to supernumerary mammae and its own similarity to gland tissue.

The growth in this case was situated in the left groin of a woman of forty-two, near the external inguinal ring, and gave somewhat the appearance of an inguinal hernia. It was first noticed two years before its removal, and during that time had not been sore or painful. It varied somewhat in size, swelling at the menstrual periods. At the time of operation it was a pedunculated mass, 16 cm. by 10.5 cm., with a pedicle 5 cm. long. On section there was thick edematous skin, and subcutaneous tissue which contained little fat; and inside, a tumor mass, 10 cm. by 7 cm. This growth is divided into two distinct parts by a band of connective tissue running transversely. The upper portion, slightly larger and more compact, consists of a thick framework of connective tissue in the spaces of which are nests of a darker and denser growth, which in places seem to form closely packed convoluted projections with fissures toward the center. In other places these nests are apparently solid. The lower part consists also of a connective tissue framework, but here the spaces are larger and are occupied by less closely packed, but more irregular, projecting masses of tissue.

Microscopically, these same differences are seen: a framework enclosing the tumor tissue; the abundant supporting network consisting of both fibrous and elastic connective tissue, and in most places very edematous. It is well supplied with blood vessels and in places shows spots of round-cell infiltration. The new growth consists of both connective tissue and epithelial tissue; and here again is the same difference as is seen with the naked eye. In some parts of the tumor, especially the upper, the nests show cross-sections of ducts lined by a fairly definite columnar epithelium and having a more or less definite basement membrane, together with bunches of more irregular cells; the whole imbedded in fibrous connective tissue which, from the presence of numerous