An Address ON DILATED STOMACH.

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EFFICIENT treatment requires accurate diagnosis. Accurate diagnosis in a gastric case means the determination of the size, shape, and position of the stomach, the condition of its motor functions with regard to tone, peristalsis, and the rate of evacuation, and lastly, the condition of its secretory functions.

When we think of this long list of requirements and of the comparatively small amount of information given by the ordinary physical methods of examination, we cannot be surprised that diagnosis in gastric diseases is generally much less satisfactory than in thoracic diseases, and that cancer of the stomach is still rarely recognized before it is too late for radical treatment.

I propose first to describe very briefly the causes and symptoms of dilatation of the stomach, then to show in some detail how recent researches on the motor functions of the stomach have made a more accurate diagnosis possible, and finally, to discuss briefly how the information obtained bears upon the treatment of the different forms of dilated stomach.

I. CAUSES OF DILATED STOMACH.

Dilatation of the stomach may result from (a) atony of its muscular coat, and (b) obstruction at the pylorus or in the duodenum.

(a) *Atony*.—Atony may result from conditions which directly affect the muscular tissue itself, such as prolonged febrile diseases, anaemias, and cachectic conditions. More commonly, however, it is secondary to depression of the central nervous system; this often leads to depression in the peripheral nervous system, upon which the tone of the involuntary muscle of the alimentary canal depends. Consequently neurasthenia, hypochondriasis, and melancholia are common causes of gastric atony, and even in their absence prolonged overwork and depressing emotions may lead to atonic dilatation of the stomach. The atony is increased by the direct effect on the musculature and the nervous system of the malnutrition, which is generally associated with these conditions owing to the accompanying loss of appetite.

(b) *Pyloric Obstruction*.—Pyloric obstruction is due in the vast majority of cases to the results of gastric or duodenal ulceration or to cancer. A gastric ulcer situated in close proximity to the pylorus may as a result of the oedema and vascular engorgement at its edges lead to obstruction, which disappears when the ulcer heals. More frequently a permanent obstruction is produced by contraction of the fibrous tissue formed when an ulcer heals. Cancer of the stomach does not commonly arise at the pylorus itself, but in the majority of cases it spreads from the lesser curvature so as finally to involve the pylorus.

Spasm is often stated to give rise to pyloric obstruction, but the evidence that it can do so is inconclusive, except, perhaps, in the hypertrophic pyloric stenosis of infants. External pressure very rarely gives rise to pyloric obstruction, and simple adhesions between the pylorus and the neighbouring viscera do not, as a rule, interfere with the passage of food into the duodenum. Gastroparesis cannot by itself lead to pyloric obstruction, as any kink which it might produce would be in the duodenum at the point where it becomes fixed, the pylorus being sufficiently mobile to drop with the rest of the stomach when the erect posture is assumed. Such a kink in the duodenum only causes obstruction in very exceptional cases, any dilatation in a dropped stomach being generally due to coexisting atony.

II. SYMPTOMS OF DILATED STOMACH.

(a) *Atonic Dilatation*.—In atonic dilatation of the stomach the chief complaint is an uncomfortable sensation of fullness coming on during or immediately after a meal. This leads to a progressive diminution in the amount of food taken by the patient, who hopes thereby to diminish his discomfort, but actually increases the atony by starving his nervous and muscular tissues. In uncomplicated cases pain is never present and vomiting is very infrequent.

(b) *Pyloric Obstruction*.—In dilated stomach due to pyloric obstruction, in addition to the sensation of fullness, attacks of severe pain are frequently brought on by the violent peristalsis, which occurs at varying intervals after meals in the attempt of the stomach to overcome the obstruction. Vomiting is a frequent symptom in severe cases; it may occur before breakfast, and articles of food may be brought up which have been eaten many hours or even days before. Wasting is progressive and the tissues become abnormally dry and inelastic; the patient has generally little appetite, but complains of great thirst. The urine is scanty and obstinate constipation occurs.

It is now known that auto-intoxication from the absorption of poisons retained in a dilated stomach is extremely uncommon, tetany, which is a rare complication in severe

cases of pyloric obstruction, being the only example of this.

In addition to the symptoms already enumerated others depending upon the cause of the obstruction, such as gastric ulcer or carcinoma, are, of course, also present.

III. INVESTIGATION OF THE MOTOR FUNCTIONS OF THE STOMACH.

(a) *Size, Shape, and Position*.—The x rays have shown that the normal shape and position of the stomach differs considerably from the classical descriptions, which were derived from what was found *post mortem* and during operations. Under the latter conditions the tonic contraction of the stomach is, as a rule, almost completely relaxed, and as soon as the abdominal wall is opened the intra-abdominal pressure, which is the chief factor in keeping the viscera in position, falls to that of the atmosphere.

The *fundus* is the part of the stomach which lies above the cardiac orifice; in the vertical position the *body* is of nearly uniform width, and is situated entirely to the left of the middle line, being either vertical or inclined slightly towards the left (Fig. 1). Its separation from the *pyloric* part of the stomach is indefinite, but can usually be

Fig. 1.—Normal stomach, as seen with the x rays in the vertical position. O, End of oesophagus; F, fundus of stomach, containing gas; P.C., incisura angularis; P.C., pyloric canal; U, umbilicus.

recognized with the x rays in the lesser curvature at the *incisura angularis*. The pyloric part of the stomach consists of the *pyloric vestibule*, which is directed upwards and slightly backwards as it turns to the right, and the *pyloric canal*—a definite tubular portion, nearly an inch long, which makes a sharp angle with the pyloric vestibule as it passes backwards. In the vertical position the greater curvature almost invariably reaches below the umbilicus; it rises 2 or 3 inches when the horizontal position is assumed (Fig. 2).

Inspection of the abdomen may reveal the outline of the stomach in patients with very thin abdominal muscles, especially if pyloric obstruction has led to excessive activity of peristalsis. *Palpation* under similar circumstances enables us to feel the lower border of the stomach, and occasionally even in normal individuals a part of it can be recognized. These methods of examination are, however, of very limited application, and with palpation it is often difficult to distinguish with certainty between the stomach and the transverse colon.

When the gastric contents can be splashed with unusual ease on abdominal palpation, or on shaking the patient, it may be possible to determine the approximate size and position of the stomach from the area in which the splash is best heard, but it is often impossible to obtain any splashing at all, and it should be remembered that it may sometimes be produced in the transverse colon.

Percussion, although frequently employed in examining the abdomen, can in reality give very little information. The empty stomach is a collapsed tube with its walls in contact with each other, except at the fundus, which contains gas. The latter gives a resonant note, but the note over the greater part of the organ is quite indistinguishable from that over the surrounding viscera. After food has been taken the gas contained in the stomach still gives a resonant note, but the area thus marked out is small in comparison with the total size of the stomach (Fig. 3). Thus percussion may give some idea as to the quantity of gas in the stomach, but it cannot possibly help in the determination of its size, shape, or position.

In recent years *auscultatory percussion* and *friction* have often been used with the object of mapping out the stomach; the stethoscope is placed over a point which is known to lie within the gastric area, and the abdomen is percussed in different directions from the stethoscope until a change in note is heard. A very definite outline is by this means obtained, which often approximately corresponds with what was formerly supposed to be the area occupied by the stomach. Investigations with the x rays have, however, shown that these methods are quite valueless. On numerous occasions I have marked out

the supposed position of the stomach by auscultatory percussion and friction after a bismuth meal had been given. I have obtained a definite outline, which was identical with that obtained at the same time by other observers, several of whom had, like myself, previously made frequent use of the methods. I have then placed a metal wire over the outline; on looking at the abdomen

with the x rays it was found that in no case did the area marked out by the wire show any resemblance to the true shape of the stomach (Fig. 3). Often the "stomach" marked out by these methods barely overlapped the position it really occupied. Why such definite areas can be marked out by these methods I do not know, but any one who will take the trouble to compare them with the true outline of the stomach, as determined by the x rays, will convince himself of the futility of auscultatory percussion and friction.

Inflation of the stomach with gas is an exceedingly valuable method. The stomach being empty, the patient drinks in rapid succession two quantities of 4 oz. of water, in which are dissolved respectively $1\frac{1}{2}$ drachms of sodium bicarbonate and $1\frac{1}{2}$ drachms of tartaric acid. The carbon dioxide evolved distends the stomach in such a way that it can often

be easily seen and felt; in every case its size and position can be determined by percussion, as sufficient gas is present to fill all parts of the stomach. Normally the distance between the lesser and greater curvature should not be greater than 4 in., and the greater curvature should not reach below the umbilicus. Dilatation and an abnormally low situation of the stomach can thus be readily recognized. This method, however, has the drawback that it can only be used in a horizontal position, as the gas is immediately eructated on sitting up. It is, therefore, frequently impossible to recognize the presence of ptosis, as in the majority of cases this is only present when a vertical position is assumed. Very little information can be obtained as to the shape of the stomach, as inflation with gas produces considerable distortion, the shape assumed by the stomach when rapidly distended with gas being quite different to its natural shape when slowly filled with food. The method is also contraindicated when a gastric ulcer may be present, owing to the danger of perforation; this is a serious disadvantage, as ulceration

frequently leads to pyloric obstruction, hour-glass constriction, and irregularities in the gastric outline, due to adhesions.

X Rays.—The size, shape, and position of the stomach can be readily and accurately determined, both in the vertical and horizontal position, by means of the x rays after a meal of porridge or bread and milk containing 2 oz. of bismuth oxychloride has been given. There is

Fig. 2.—Normal stomach, as seen with the x rays in the horizontal position.

Fig. 3.—Comparison of the results obtained in outlining the stomach in the horizontal position with the x rays (continuous outline), auscultatory percussion (dotted outline), and simple percussion (shaded area).

no possibility of error in determining the shape of the stomach, although, of course, mistakes may be made in the interpretation of unusual appearances. By palpation during the screen examination, the mobility of the stomach can be investigated and the presence of adhesions recognized.

(b) *Tone*.—The normal stomach adapts itself to the volume of its contents in such a way that the intra-gastric pressure remains steadily between 4 and 6 mm. of mercury, whether it is full or almost empty. The chief factor in this mechanism is the gradual relaxation of the tonic contraction of the fibres of its muscular coat. In atonic dilatation this adaptation is incomplete or absent, the stomach acting as a more or less passive sac, which

of accuracy, $1\frac{1}{2}$ drachms of sodium bicarbonate yielding with $1\frac{1}{2}$ drachms of tartaric acid 1,700 c.cm. of carbonic dioxide at the body temperature and at atmospheric pressure. The normal stomach when rapidly filled has a volume varying between 600 and 1,200 c.cm.; 1,700 c.cm. of gas will therefore be subjected to a considerable degree of tension when set free in the normal stomach, which can be readily felt as a hard tumour with a definite outline; it is generally visible, and can always be accurately mapped out by percussion. A good deal of discomfort is produced, and on sitting up the gas is eructated with considerable force. On the other hand, when the tone of the stomach is deficient, and its capacity even when empty is greater than 1,700 c.cm., it will not be tightly distended;

Fig. 4.—Gradual filling of a normal stomach. U, Umbilicus; L, upper limit of gastric contents.

does not contract upon its contents, the food dropping into the most dependent part of the organ.

Splashing and *succussion* give useful information concerning the tone of the stomach under certain definite conditions alone, as in many normal individuals splashing may occur in the stomach after an ordinary meal. If, however, two ounces of water are sipped when the stomach is empty and splashing can then be produced by palpation it may be concluded that atony is present. Normally the stomach contracts upon the fluid in such a way that all the air contained in it is pushed into the fundus, where it gives rise to a resonant note obtained on percussion over Traube's space—the area bounded on the right by the heart and left lobe of the liver, on the left by the spleen, and below by the costal margin, and merging above into

the tumour it forms is therefore softer, and its outline is less easy to determine with accuracy by palpation and percussion. No discomfort is produced; sometimes, indeed, the patient experiences a feeling of relief after the inflation. On sitting up there is less desire to eructate the gas, and it is brought up with more difficulty and less force.

More accurate information can be obtained as to the degree of atony by inflating the stomach through a tube by means of a syringe of known capacity, the amount of air required to give rise to slight discomfort being estimated by the number of times the syringe has to be emptied. When, therefore, a stomach tube has to be passed for other reasons, inflation can be carried out by this method instead of with carbon dioxide.

Fig. 5.—Gradual filling of an atonic stomach.

the pulmonary resonance. When the stomach is atonic the body and pyloric part does not contract upon the fluid, which forms a layer over the back of the whole of the stomach, the gas being spread over the front so that a resonant note is obtained below the costal margin; the resonance may extend as far down as the umbilicus and even be absent from Traube's area. Under these conditions the part of the stomach which is below the costal margin contains both gas and fluid, and consequently splashing is produced on palpation.

Inflation.—When the stomach is inflated with carbon dioxide in the manner already described, the degree of gastric tone may be estimated with a considerable amount

X Rays.—Owing to the adaptation of the stomach to the volume of its contents, it is found on examining the stomach in the erect position with the *x* rays that there is little difference in the upper level of its semi-fluid contents whether their volume be 5 oz. or 2 pints, and the greater curvature is very little depressed as the stomach is gradually filled (Fig. 4). When the stomach is atonic this adaptation to the volume of its contents does not occur; the food is seen to drop to the most dependent part, its upper level slowly rising and the greater curvature becoming more dependent as the volume of its contents increases (Fig. 5).

(c) *Peristalsis*.—The *x* rays have shown that normal

peristalsis begins immediately after the food is taken, each peristaltic wave starting as a constriction near the middle of the body of the stomach. It deepens as it slowly progresses towards the pylorus, until about 1 in. from the entrance of the pyloric canal it reaches such a depth that part of the pyloric vestibule becomes almost completely separated from the rest of the stomach. The part thus cut off then diminishes in size in every direction, some of its contents being from the first forced through the pyloric canal into the duodenum, the remainder being forced back as an axial reflux stream into the stomach (Fig. 6).

Deficient peristalsis may occur in association with atony, but it is rarely well marked, and in the majority of cases of atonic dilatation of the stomach, peristalsis is seen to be of normal strength. In pyloric obstruction peristalsis is unusually vigorous, even when a considerable degree of atony has resulted from the prolonged stasis of food in the stomach.

Inspection.—In unusually thin women the normal peristalsis of the stomach is occasionally visible, but in the majority of cases the presence of visible peristalsis indicates organic pyloric obstruction. The patient should be examined after a meal, and, if possible, when pain is present. In doubtful cases peristalsis can be rendered more obvious by massage.

Palpation.—At a period preceding that in which peristalsis is visible it may often be felt if the hand is kept for some minutes gently pressing upon the right side of the abdomen a little above the umbilicus. A periodic hardening can be recognized, during which the hand is raised. It is important to keep the hand in position for some time, as otherwise the hardening may be mistaken for a rigid rectus muscle.

X Rays.—Deficient peristalsis cannot be recognized with certainty by any method except the x rays. In pyloric obstruction the peristaltic waves can sometimes be seen to commence in the fundus instead of in the centre of the body, and to lead to unusually great depressions in the outline of the organ at a period considerably earlier than that in which it becomes visible through the abdominal wall.

(d) **Rate of Emptying.**—The rate at which the stomach empties itself depends upon the condition of the pylorus, the strength of peristalsis, and, to a much less extent, the tone of the gastric musculature. Under normal conditions the stomach is empty about two hours after a light breakfast and about four hours after an ordinary dinner. If pyloric obstruction slowly develops, hypertrophy of the muscular coat of the stomach occurs, and the increased strength of peristalsis is at first able to cope with the increasing difficulty of evacuation. A time at last comes when compensation is incomplete, and a certain amount of stasis occurs. This steadily increases as the obstruction progresses, and the stagnating food gives rise to catarrh of the mucous membrane and atony of the muscular coat and consequently to dilatation of the stomach, although peristalsis continues to be more vigorous than under normal conditions. The sequence of events is strictly comparable to the dilatation of the left ventricle, which occurs when

its hypertrophy becomes insufficient to deal with a progressive aortic stenosis.

As peristalsis is entirely independent of tone, uncomplicated atony has comparatively little effect on the rate of emptying of the stomach. The gastric contents begin to pass into the duodenum immediately after their entry into the stomach, and evacuation continues at the normal rate. It is only in advanced cases of atony that more than the last traces of the food remain abnormally long in the stomach; the terminal stasis which occurs even in slight cases is due to the fact that the gastric tone does not increase *pari passu* as its contents are reduced in quantity, so that the residue remains in the most dependent portion of the body of the stomach, and does not reach the pyloric part at all. When lying on the right side the pyloric vestibule is the most dependent part of the organ, and consequently the food collects in it; however advanced the atony may be, there is very little stasis if this position be assumed, so long as peristalsis is of normal strength.

Splashing and Succussion.—The stomach should be completely empty in less than six hours after dinner. If, therefore, splashing and succussion can be elicited six hours after such a meal, it may be concluded that stasis is present. This may be due either to atony (if the erect

position has been maintained), feeble peristalsis, or pyloric obstruction. If, however, these signs are present twelve hours after dinner—at 9 a.m., for example, if dinner was taken at 9 p.m.—organic pyloric obstruction is almost certainly present. An important exception is ulceration in the neighbourhood of the pylorus, which may cause a continuous secretion of

Fig. 6.—Successive stages of normal peristalsis in the pyloric vestibule. D, Duodenum; P.C., pyloric canal.

gastric juice, so that the stomach is never empty, although there is no pyloric obstruction and no delay in the passage of food into the duodenum.

When the symptoms or physical signs suggest the possibility of pyloric obstruction, it is essential to investigate the case further by means of a stomach tube. A dinner containing meat, green vegetables, and potatoes, sweets, and some raisins or dried plums, is given at 9 p.m., and the stomach tube is passed at 9 a.m., nothing having been taken in the interval. If the patient does not involuntarily strain he is told to do so, as the stomach can generally be completely emptied in this way without any siphonage or pumping. If nothing is brought up, half a pint of water is poured through the tube; on again straining this is brought up together with any traces of gastric contents which were insufficient to be expelled alone. In atonic dilatation the stomach is always empty twelve hours after a meal. In chronic gastritis, especially when due to alcohol, a small quantity of thick alkaline fluid, consisting mainly of mucus and often bile-stained, may be present. In the continuous secretion which results from an ulcer near the pylorus even in the absence of obstruction, a small quantity of very acid fluid without any food residue is found. When an ulcer has led to organic obstruction, starch granules and vegetable debris, but no meat fibres, are present, in addition to some acid fluid; the quantity of the latter is much increased if the ulcer is still active, as hypersecretion then occurs in addition to stasis.

When the obstruction is due to cancer, the gastric contents are of thicker consistence and contain debris of both vegetable and animal food; free hydrochloric acid is absent, "active" hydrochloric acid is greatly reduced in quantity, and lactic acid is present.

The *x* rays give much less information than the stomach tube as to the rate of evacuation. Well marked obstruction can be recognized by the contrast between the unusually small quantity of bismuth which enters the duodenum and the very active peristalsis. The time required for complete evacuation cannot be accurately determined; on the one hand a little bismuth frequently sticks to the mucous membrane long after the rest of the meal has left the stomach, especially when the mucous membrane is covered with mucus as a result of catarrh. I have also known the mistake made of allowing the patient to take another meal before the last examination; in that case the remaining bismuth is mixed with the new food, and consequently its final disappearance does not take place until the whole of this later meal has left the stomach. On the other hand there may be a mild degree of obstruction, in which all the finely divided food and bismuth pass into the intestine, although larger particles, such as raisins or insufficiently chewed pieces of meat, are retained.

IV. TREATMENT OF DILATED STOMACH.

(a) *Atonic Dilatation.*—The most important part of the treatment of atonic dilatation is to ensure a proper amount of rest in the recumbent position. This is very valuable for the depressed nervous system, and it also diminishes the quantity of food required to maintain metabolic equilibrium, and so permits weight to be gained even if no additional food is taken. Moreover it places the atonic stomach in a position of mechanical advantage. This is particularly true if the patient lies on the right side, the *x* rays having shown, as I have already pointed out, that this is the position in which an atonic stomach empties itself most rapidly. The patient should lie down as soon as the meal is finished, but sit up during the meal itself, as otherwise the food may stagnate and undergo fermentation in the dilated fundus, and not reach the pyloric vestibule at all until the next meal is taken. In slight cases it is only necessary for the patient to lie down for an hour after each meal; in advanced cases he should remain in bed all day until the tone of the stomach has improved.

An ordinary mixed diet should be given, but the bulk of the meals should be as small as is compatible with the provision of a proper amount of nourishment, and no fluids should be drunk during meals. The *x* rays have shown that water taken on an empty stomach runs straight out into the duodenum, but mixes with any food which may be present if taken during or after meals, and only leaves slowly with the more finely divided part of the food. Consequently it is best to take the fluids when the stomach is empty. A glass of water may be taken on rising in the morning, a glass of milk or some broth or beef tea at 11.30, if breakfast is at 8.30 and lunch at 1; one or two cups of tea at 5 p.m., and a glass of milk last thing at night. Carbohydrates need not be restricted in uncomplicated cases of atony, but when there is any catarrh the quantity of sweet and starchy foods, which are liable to undergo fermentation in the stomach, should be reduced.

Abdominal massage is often very useful. If an *x*-ray examination has been made in the horizontal position the exact localization of the stomach will be known and consequently massage can be applied directly to the organ. If this precaution is not taken the massage may almost completely miss the stomach. I have on a number of occasions allowed the masseur to give his first treatment under the *x* rays after a bismuth meal, as he can then find where and how he can best massage the stomach itself. The treatment should be given every morning an hour after breakfast, when the stomach is nearly empty, the duration of the treatment being gradually increased from ten minutes to half an hour.

Electricity is of comparatively little value. My experiments have shown that faradism is without action on the alimentary canal; a tonic contraction, however, occurs in the whole area underneath an electrode during the passage of a galvanic current, a greater effect being produced by the anode than the kathode, but the contraction is probably only slight with the maximum current the patient

can tolerate, except in very thin individuals. If, therefore, there are facilities for electrical treatment, the large kathode should be placed on the back and a smaller anode is moved slowly over the gastric area. As strong a current as the patient can bear with comfort should be used, and the treatment may be given for ten minutes after the massage.

It is doubtful whether drugs such as strychnine and ergot have any effect upon the tone of the stomach. The former, however, is often of use, as it improves the appetite and thus helps to overcome the malnutrition so often present. It may be combined with dilute hydrochloric acid, particularly if there is any deficiency in the gastric secretion, and with a bitter such as gentian, which stimulates the appetite and consequently increases the psychical secretion of gastric juice. When an aperient is required on account of constipation, which cannot be overcome by other means, a drug such as aloes is most useful, as it probably has a stimulating action on the gastric musculature analogous to that which it exerts on the colon.

In uncomplicated cases lavage is likely to do more harm than good. In severe cases complicated by catarrh lavage with plain water may be of use; the addition of antiseptics is unnecessary and likely to increase the catarrh; and it has been shown experimentally that sodium bicarbonate, which is commonly supposed to dissolve the mucus, does not do so under the existing conditions. The tube should be passed last thing at night, and the patient should try to evacuate any gastric contents through the tube before water is poured down. Not more than half a pint should be poured into the stomach, as larger quantities tend to increase the atony by the rapid distension they produce. It is rarely necessary to repeat the lavage with more than two successive half pints, and frequently the first half pint is sufficient. When there is much malnutrition, half a pint of milk containing some concentrated protein food may be drunk after the lavage.

Gastro-enterostomy is strongly contraindicated. The bad results following the performance of this operation in the absence of organic disease of the stomach and duodenum have been responsible for the unfortunate disinclination on the part of some medical men to recommend it in cases in which it is really indicated.

(b) *Pyloric Obstruction.*—The treatment of pyloric obstruction is gastro-enterostomy. In well-marked cases it is useless to waste time by lavage or other medical treatment, as the improvement which follows operation is immediate and progressive. Only when the patient is already so emaciated that doubts are raised as to whether he is strong enough to undergo an operation, is it justifiable to try by lavage, by the administration of saline solution by the rectum, and by giving frequent small and concentrated feeds to improve his condition before the operation is performed. By this means a considerable gain in weight may occur, which is due particularly to the absorption of fluid, and the gastric atony may diminish, and so increase the probability of a successful result of the operation. The patient should be weighed every day, and it should be clearly understood that no delay is permissible unless the weight is steadily increasing; if there is no gain in weight the operation should be performed in spite of the risk.

When the obstruction is only partial and an active ulcer is present, it is sometimes worth while trying the effect of medical treatment, as the obstruction is largely due to the surrounding inflammation, which disappears when the ulcer heals, and if the ulcer is not very large the scar produced may give rise to no obstruction. I have seen such cases recover completely without operation.

The most striking example of the disappearance of obstructive symptoms was a man of 50, who had suffered for twenty-two years from typical symptoms of duodenal ulcer. His stomach was dilated and there was visible peristalsis. For business reasons he had to postpone the operation, which I advised, for four months, during which he was carefully dieted and treated with oil and alkalis. He lost his pain and the dilatation and visible peristalsis disappeared, but on account of the long history I still thought an operation advisable. Mr. Rowlands operated and found a number of definite scars on the outer surface of the duodenum, but the ulcers had completely healed and there was now no obstruction, although four months earlier at least one ulcer must have been active and the thickening round it sufficient to produce well-marked obstruction.

The treatment of such cases should be that of ordinary gastric ulcer, the use of olive oil being of particularly great

value, as it causes relaxation of the pylorus in addition to inhibiting the secretion of the gastric juice. As there is certain to be more or less continuous gastric secretion, the stomach should be washed out with an alkaline solution every evening. If the symptoms do not disappear after four weeks, or if they recur in spite of careful dieting, an operation should be advised.

PREVALENT RAIN-BEARING WINDS AND THE MILK SUPPLY OF MANCHESTER DURING THE YEARS 1896-1909.

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In the spring of last year Professor Delépine of Manchester read before the Royal Society of Medicine a very valuable and interesting paper dealing chiefly with the distribution of bovine tuberculous mastitis amongst the farms supplying Manchester with milk. 1,524 farms scattered over an area of nearly 5,000 square miles were carefully investigated and mapped, and it was found that remarkable differences in the prevalence of the disease existed between different districts. Professor Delépine endeavoured to use these differences in prevalence to demonstrate a relation between local incidence of tuberculous mastitis and local state of cowsheds and herds, a relation which, if possible to prove, is obviously of profound importance.

There can be nothing but admiration, in considering this paper, for the way in which the available facts have been collected and arranged, for the great time, labour and skill expended on them, and, not least, for the frank indication of the unavoidable limitations of the material. But with all these in view, seeing the importance of the subject and the apparent magnitude of the opportunity, one cannot but deplore that the result attained fell so far short of being conclusive. While presenting considerable evidence of the influence of what may be called "farm management" in determining a higher or lower degree of prevalence of the disorder, Professor Delépine found himself unable to escape from the embarrassment of some other influence or influences which were unknown to him.

In quoting the following passages from his paper I hope he will not consider I have in any way misrepresented his conclusions. I have lettered the first two paragraphs (A) and (B) respectively for convenience of reference further on. The lettering and figures in the text here and throughout this paper refer to his maps in the *Proceedings of the Royal Society of Medicine*.¹

(A) It would appear from this that in every respect the shippens which were found to produce tuberculous milk were worse than the others [worse as regards the state of the cowsheds and herds]. But if instead of comparing the averages only one compares in each group the state of the tuberculous and non-tuberculous farms in various latitudinal zones, it becomes evident that the averages do not convey the whole truth, for if the non-tuberculous farms situated south of Manchester (Group A, Division XX to XXXI) are compared with the tuberculous farms also situated south of Manchester, one finds that the tuberculous farms in Zone III to XIX, XX to XXI and XXII, are really more satisfactory than the non-tuberculous farms in Zone XX to XXXI, and that it is only south of Zone XXII that the tuberculous farms are worse in every respect than the non-tuberculous farms (not including the Manchester farms).

(B) Another unexpected fact is obvious. Of the five divisions of tuberculous farms, the one corresponding to Zones XXIII and XXIV is undoubtedly the worst, while Division III to XIX is distinctly the best; but notwithstanding the considerable differences indicated in the table, the number of cows with tuberculous udders per cent. of the total number of cows is about the same in all the zones. The same may be said of the cows suspected of disease of the udder; there are slight differences, but these do not correspond in the least with the condition of the farms in the respective zones. I do not think that the differences in these percentages should be taken to indicate important differences in the incidence of tuberculosis, as they may possibly be affected by the more frequent inspection of the proximal farms, which would almost certainly lead to the discovery of some few cases overlooked in the first visits.

It is, however, clear that the condition of the farm, though important, is not the dominant factor, and this makes it necessary to believe in the existence of some cause capable of overpowering the most favourable conditions, and practically independent of the most influential predisposing factors, to account for the focal distribution of cases of tuberculous mastitis.

A careful consideration of the statistical facts recorded in this paper and of facts which I have observed in connexion with a number of farms that I have been able to study closely has led me to the conclusion that cows in a state of advanced tuberculosis, and emitting discharges loaded with tubercle bacilli, constitute the chief factor determining the distribution of bovine tuberculosis.²

Reviewing these statements and the facts recorded in his paper, it is evident that Professor Delépine is correct in thinking that some other influence (or influences) which he had not taken into account had interfered with his result, preventing him from demonstrating the relation, which he has otherwise made so probable, between farm management and the prevalence of bovine tuberculous mastitis. His assumption, however, that this influence is that of "cows in a state of advanced tuberculosis, and emitting discharges loaded with tubercle bacilli," cannot be admitted, so far as the distribution of disease amongst the whole number of farms (tuberculous and non-tuberculous) is concerned.

Such discharges may, it is true, account for the fact that within the different groups of tuberculous farms—that is, amongst farms where advanced cases are generally present (since cows with tuberculous mastitis "are, in the majority of cases, suffering also from more or less advanced tuberculosis of other organs")³—no sanitary measures short of the removal of these cases appeared to make much difference in the percentage of cows suffering from tuberculous mastitis; and we may conclude, with Professor Delépine, that this reasonable explanation meets the difficulty raised in his paragraph which I have lettered (B). But it is impossible so to explain away the difficulties referred to in paragraph A, or to account for the distribution of tuberculous farms amongst the whole number of farms. Professor Delépine himself tells us⁴ that "although infection from farm to farm is not impossible, it is not of common occurrence." Besides, even if one admitted the assumption to be a possible truth—which cannot be done—it would only move the question a step further back to, "What, then, accounts for the distribution of these advanced cases in the whole area?"

The fact is that Professor Delépine has not taken into account, as a possible factor in the problem, a most powerful influence affecting the prevalence of tuberculosis—one to which, during the past ten years, I have repeatedly called attention—namely, the influence of strong prevalent rain-bearing winds. These winds, I have shown over and over again, have a most remarkable power of increasing the mortality from human tuberculosis of the lungs in localities exposed to them, and, as I have more lately indicated, of similarly increasing the mortality from other forms of human tuberculosis.⁵ It is not unreasonable to suppose that they may similarly influence the distribution of bovine tuberculosis, though this has not hitherto been suggested. Dr. Delépine's maps afford a unique opportunity of ascertaining whether they do so or not. I propose to show that they do, and that the "cause capable of overpowering the most favourable conditions," which he found to be interfering with his conclusions, was just this influence of wind (possibly together with others which are as yet unknown); also that when steps are taken to prevent the interference of wind exposure with the other investigation, the relation between prevalence of tuberculous mastitis and farm management seems (if I rightly understand and interpret his figures and statements) to become capable of proof.

Before undertaking the detailed examination of the topography of so wide an area it is obviously necessary to inquire into the nature of the available material, in order to ascertain how far satisfactory conclusions may be based upon it; so that it is in no carping spirit that I review the limitations of the very valuable facts which Professor Delépine has presented.

In the first place, the farms indicated are, in many districts, only a few of the milk-supplying farms in those districts, and it might be alleged that these relatively few farms cannot be regarded as representative of their districts. But seeing that they are selected simply because they supply Manchester with milk, and for no other reason, I take it that they may reasonably be regarded as representative of their surroundings, provided a considerable number are grouped together. Dr. Delépine has evidently taken this view.

Again, farms remote from Manchester have apparently