in proportion to their means, the cash received plus the amounts paid by the Insurance Committee on behalf of insured persons would materially lighten the burden of the new hospitals on the rates.

While no one would be compelled to enter hospital, I think that entry into hospital should, in cases for which hospital treatment may be certified necessary or desirable by the medical attendant, be made a condition precedent to the granting of financial help to the sick man's dependents. State help for the dependents is, in my opinion, an essential for the success of the scheme I have outlined, but the State is bound to consider economy. It would be wasteful to make grants when the practitioner certifies (in effect) that the sick man's recovery will be prejudiced or delayed by his remaining at home.

CONCLUSION.

I have endeavoured to show how the infirmaries can be rendered more useful after transfer, which I regard as practically certain. Dr. C. M. Wilson intimated in his opening remarks that there is some risk of the policy with reference to the infirmaries being settled to meet political exigencies. I incline to the opinion that a well-considered scheme prepared by the profession, in consultation with the officials, will be preferred by the public to a scheme prepared by politicians based on theoretical considerations. I think we may claim first that we know the medical necessities of the people, and, secondly, that we still possess their confidence.

AN INVESTIGATION OF THE CAUSE AND RELIEF OF PAIN IN GASTRIC ULCER.*

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THE object of the present communication is to show that an important element in the pain of gastric ulcer is due to distension of the stomach, and can be abolished by reducing the intragastric pressure. Two methods have been adopted in this investigation: 1. A fine rubber tube similar to that used for withdrawing stomach contents in the fractional test-meal method is passed into the stomach. There is some lead in the lower end of the tube, so that it can be localised by means of X rays. Air or oxygen is passed into the stomach through the tube from a reservoir connected with a water manometer, so that the pressure exerted by the air current can be measured. The patient is asked to describe his sensations, whether of fullness or pain, while his stomach is being distended. 2. The patient is asked to pass a similar tube into the stomach when pain is experienced, and in many cases the pain is relieved within a few minutes by release of pressure. The tube should contain a series of holes extending from its end in the stomach upwards as far as the cardiac orifice. Stomach contents may be regurgitated through the tube. The gastro-duodenal tube is a modification of the gastric tube. It connects the stomach with the duodenum, so that pressure is equalised through the pylorus. It is about 2 feet long, and contains holes about $1\frac{1}{2}$ inches apart throughout its length. Both ends are made opaque to X rays by means of short pieces of thick lead fuse wire placed inside the tube between glass beads (in order to keep the digestive juices away from the lead) and securely fastened with silk. To one end of the tube is attached a piece of silk about 27 inches long. The end of the tube not attached to the silk is passed into the stomach, and it then usually passes quite readily through the pylorus. The upper end of the tube is then anchored in the stomach 22 inches from the lips by means of the silk, which can be fastened round the ear or round a dental plate or pinned on the dress. The position of the tube can easily be determined by

skiagraphic examination after the stomach has been outlined with a little barium sulphate suspension. It is important not to pass this tube too quickly into the stomach, as if the proximal end reaches the stomach before the distal end has reached the pylorus the tube may become tied into a knot and fail to get through at all. The ordinary thin rubber tubing gets readily acted on by the digestive juices, and such a tube does not usually last more than two or three weeks if kept in position most of the time. It should be removed and examined at least once a week. The thicker-walled tube, introduced by Dr. J. A. Ryle for fractional test meals, is much more durable.

At the outset it should be pointed out that it is not claimed at this stage that the use of these tubes should become a general method of treatment for peptic ulcer. The usual methods of medical treatment are most satisfactory, and of these methods rest in bed is possibly the most important of all. In these circumstances pain usually disappears completely, and in several instances the writer has obtained radiographic evidence of the ulcer becoming less, and completely disappearing in a few weeks. His thanks are due to Dr. Lindsay Locke for some of this evidence. This treatment by means of the tubes has been brought forward rather as evidence of his main proposition, that the pain in gastric ulcer is often chiefly due to distension from increased intragastric pressure and as a preliminary to further work on the subject. To show that the other factors concerned with the relief of pain were absent in the cases it should be stated that the patients were mostly out-patients, some of them doing their usual work; that they came up complaining of pain, that they were encouraged as far as possible to take ordinary food, and that to begin with, at any rate, no drugs were given. Later on in some cases olive oil and liquid paraffin were ordered.

Effect of Intragastric Pressure on Gastric Pain.

The effect of intragastric pressure on gastric sensation has been described by Dr. A. F. Hurst,¹ in the case of two healthy people. He passed air into the stomach, using the kind of apparatus already described, with the exception that a mercury manometer was used instead of a water manometer. The latter is, of course, more delicate owing to its wider range of movement. The sensation produced by such means was one of fullness. The stomach then accommodated itself by becoming larger, the pressure fell, and the feeling disappeared, only to return again when the pressure was raised by passing more air into the stomach. Dr. Hurst observed that there was no sensation of pain accompanying the fullness, except when the stomach was suddenly distended with a large volume of gas, as in the case when sodium bicarbonate and tartaric acid were swallowed immediately after one another. He suggested that gastric pain was more commonly produced by the distension of a part of the stomach, for instance, at the pyloric end, when the active peristaltic wave is on the point of forcing some of the stomach contents through the pylorus. The present observations point to the general intragastric pressure as being of considerable importance in the production of pain in gastric ulcer. Exactly the same variation in the feeling of fullness as that described by Dr. Hurst has been noticed many times in the present series of observations; and in cases where there was reason to believe that no active ulceration was present a sensation of fullness was described, but no pain.

CASE 1.—G. W., a woman, aged 36. In Guy's in 1918. X ray: Tender lesser curvature projection with constriction of greater curvature. The projection had disappeared by the end of her stay, but the constriction remained. Nov. 22nd, 1920: Patient had been free from symptoms for some months. X ray: Midgastric constriction seen with slight tenderness on lesser curvature. There was probably cicatrisation present. Gastric pressure test: 500 c.cm. passed in at 12 cm. pressure. No effect. Another 500 c.cm. were then passed in the pressure, gradually falling to 8 cm. A sensation of fullness noticed but no pain at all. At the end it was seen that the tube had penetrated into the lower compartment of the stomach. Both compartments were much dilated.

CASE 2.—N. B., a woman, aged 51, under the care of Dr. H. French. Indigestion since 30 years old. Attacks of pain in epigastrium and lower down over the umbilicus. Pain is worst if she has wind. When examined she had had no pain at all for six or seven weeks. X ray: Hour-glass stomach with slight tenderness on pressure at

* A paper read before the Medical Section of the Royal Society of Medicine on Jan. 25th, 1921. The expenses of this investigation were defrayed by a grant from the British Medical Association.

the site of the constriction on the lesser curvature. The tube when passed was entirely in the upper compartment of the stomach. Gastric pressure test: 400 c.cm. passed in at 20 cm. pressure. Feeling of distension relieved by eructation, no pain at all. Operation by Mr. C. H. Fagge a few days later. Cicatricial hour-glass stomach found, with thickening at pylorus. On opening stomach for gastropasty the scar of a healed ulcer was seen on the lesser curvature at the site of the constriction.

CASE 3.—D. R., a woman, aged 30. Since 24 years old she has complained off and on of fullness of stomach and nausea, and difficulty in bringing up wind, with dull pain and tenderness in epigastrium. She is greatly relieved by a belt. X ray: Stomach dropped and atonic; lesser curvature below iliac crest. Stomach empty after 4½ hours. No evidence of ulcer. Gastric pressure test: 110 c.cm., and later 330 c.cm., of air introduced at 6 cm. pressure. Feeling of fullness to the right of the umbilicus, and wind eructated with much relief. No pain experienced at all. She had been resting in bed and her symptoms had greatly improved before the test was carried out.

In another case complaining of hunger pains where there was X ray evidence of duodenal ulcer the introduction of 300 c.cm. at 20 cm. pressure into the stomach caused much distension, but no pain. This is to be expected, since the ulcer would not be affected by the stretching of the stomach wall. Sixteen cases have been examined by this method (Table I.), in all of

TABLE I.—Examination of 16 Cases of Active Ulceration in Regard to the Presence or Absence of Pain on Distending the Stomach with Air.

Position of ulcer.	No. of cases.	Increased pressure in stomach pain = +	Notes on cases with no pain response (—)
Lesser curvature.	8	7 + 2 —	One case + — on different occasions.
L. c. acute.	(1)	1 +	—
L. c. and gastro-jejunostomy.	2	2 + 1 —	One case healing.
Stomach, near pylorus.	3 (1)	2 + 1 —	One case showed temporary improvement.
Pylorus.	2	2 +	—
—	16	14 + 4 —	—

(1) X ray ; localised tenderness only present.

which there was good evidence of active ulceration in the stomach, not only from the description of the symptoms, and often from the presence of occult blood in the fæces, but from skiagraphic examination. The criterion of an ulcer has been taken to be the appearance of a projection from the stomach shadow, usually on the lesser curvature (or sometimes an irregularity in the neighbourhood of the pylorus), which is constant in position and tender on pressure. Occasionally no projection was seen, but localised tenderness made the diagnosis probable. When there are cases of this rather doubtful nature in a group their number is indicated by the bracket in the second column. When air was passed into the stomach these patients experienced a feeling of fullness, but in addition their characteristic pain was noticed, and this disappeared on again releasing the pressure. Care was taken in performing the test to ask the patient whether the distension experienced was greater than they had ever felt before. The reply always was that on previous occasions they had experienced much greater distension than was felt at the time of the inflation.

Of the 16 cases examined, 14 described the onset of their characteristic pain in addition to the feeling of fullness, though the pressure at which this occurred was very variable. The following cases show this in detail.

CASE 4.—J. F., a man, aged 40. November, 1919: Pain in epigastrium 30 minutes after a meal. Feeling of distension and vomiting. Symptoms continued off and on till Oct. 1st, the pain between June and October being described as unbearable. X ray: Small tender projection on lesser curvature. Stomach contents contain blood. Occult blood in fæces. Gastric pressure test: On two occasions positive, pain being noticed in middle line above umbilicus; on one occasion negative. About 200 c.cm. of air passed in at 20 cm. pressure. Gastric tube given on Oct. 1st, and a gastro-duodenal tube later. Relief from pain and flatulence. Patient prefers the g.-d. tube, and only uses the g. tube if he gets an attack of pain. Jan. 7th, 1921: Has not been so well for three weeks, but has not been up to report: His tubes have been perishing and the g.-d. tube broke away 10 days ago. X ray shows small tender projection still present. Jan. 21st: Has had g.-d. tube for the last week, and has had no attack of pain, except on one occasion.

CASE 5.—M. C., a woman, aged 44. Dyspepsia when 18 and nearly continuously since then. Pain in epigastrium and beneath left costal margin. Perforation of gastric ulcer on April 20th, 1920, and pain and vomiting were specially severe for some weeks before this. Ulcer stitched up and gastro-jejunostomy performed. Has been ill again the last two months. X ray: Gastro-jejunostomy acted well. Tender projection on lesser curvature of stomach. Food does not leave by pylorus. Stomach empty in five hours. Test meal: No free HCl in stomach contents. Dec. 2nd: Gastric pressure test: 150 c.cm. at 10-15 cm. pressure. Pain beneath left costal margin disappearing on releasing pressure. On Dec. 15th 400 c.cm. passed into stomach; a feeling of distension but no pain. She is better, but has been lying in bed. Relief from g. and g.-d. tube, the latter seen in position, passing through gastro-jejunostomy opening. Jan. 13th, 1921: Ulcer projection cannot be seen, but the spot is still tender. She has had no pain since Dec. 15th, and has been up all the time on ordinary food.

CASE 6.—P. F., a man, aged 61. Ten years' history of indigestion. 1916: X ray: 2/3 of barium in stomach at end of seven hours. Operation: Gastro-jejunostomy for peptic ulcer. I saw him for return of symptoms November, 1917, till July, 1918. Much aerophagy. I saw him again March, 1920, and he was much worse. June, 1920: Second operation. Ulcer found on lesser curvature adherent to liver. Stomach opened and ulcer cauterised. Operation unsuccessful in relieving symptoms. October: X ray: Tender projection on lesser curvature. Stoma acts quite well. Stomach contents bile-stained, with absence of free HCl. Gastric pressure test: 250 c.cm. at 10 cm. pressure which showed great variations. Characteristic pains observed. G.-d. tube would not pass through the stoma. He gets some, but not complete relief from gastric tube. This patient suffers much from aerophagy, taking air into the stomach by repeated attempted eructations. On one occasion when he had pain the stomach was noticed much distended without any air being introduced. The manometer attached to the g. tube registered big excursions, the pressure reaching up to 24 cm. on respiration, while it was 10 to 14 cm. when the breath was held. The tube was kept attached to the manometer for a quarter of an hour and no difference in the pain was felt. The pain felt a bit easier three minutes after disconnecting so as to allow the air to escape by the tube, and had completely gone in 23 minutes.

CASE 7.—E. C., a woman, aged 31. In Guy's two years ago for gastric ulcer; pain half an hour after meals. September, 1920: Tender mid-gastric projection on lesser curvature. Nov. 19th: Gastric pressure test 500 c.cm. at 10 cm. pressure. Fullness and characteristic pain in epigastrium and in her back. Jan. 14th, 1921: She gets relief from pain and wind from the g. tube. During the last week has used it every morning for half an hour.

CASE 8.—A. J., a man, aged 31. Pain in epigastrium and round umbilicus for five years off and on. Two previous X ray examinations not very definite. Was previously in Guy's as an in-patient. X ray: Tenderness definitely marked on the stomach side of pylorus. Fæces: Occult blood present. Stomach empties very rapidly. Gastric pressure test: 200 c.cm. at 10 cm. Typical pain in epigastrium which disappeared on releasing pressure. Relief from g. and g.-d. tubes. Sometimes after they are not effective he has pulled them up and found them blocked.

Of course, the pressure of the gas entering the stomach is only a very rough way of gauging the intragastric pressure, and it is intended to carry out further observations by means of a more accurate method. Of the two cases who did not feel any pain one showed temporary improvement in his symptoms at the time of the observations, but relapsed later. Two of the other cases failed to respond, when they were improving. One case (l.c. acute) is of particular interest as he is a medical man. After an attack of diarrhoea he suddenly developed pain beneath the left costal margin, coming on one and a half hours after meals, and made worse if ordinary food were taken. This pain had lasted for three weeks. X rays showed that the lesser curvature of the stomach was tender in one spot, but it was doubtful if a projection was seen. The stomach was normal in position. It was thought that he probably had an acute ulcer. Pain was absent when the tube was passed. 200 c.cm., and later 300 c.cm., of air were passed in at 20 cm. pressure. He noticed the appearance of his characteristic pain as well as a feeling of fullness. After the examination, possibly on account of the large amount of barium sulphate given, his pain was permanently arrested.

It might be thought that the gastric-pressure test would provide a valuable means of diagnosing active ulceration of the stomach, but, although a negative result may be of value in excluding such a condition, it does not follow that a positive result means a gastric lesion. Thus, in the case of Mary B., aged 65, under the care of Dr. French, complaining of abdominal pain, the latter was definitely increased on passing 100 c.cm. into the stomach and was lessened again by relieving the tension. Operation disclosed a carcinoma of the pancreas, and the post-mortem showed that the stomach was normal, no trace of any acute or chronic ulcer being seen.

With regard to the second method of investigation—viz., the relief of pain on passage of one or other of the

tubes—observations have been made on 16 cases. They are summarised in Table II., and certain illustrative cases are described more fully. It is not claimed that

TABLE II.—*Examination of 16 Cases of Active Ulceration in Regard to the Relief of Pain on Passing a Tube.*

Position of ulcer.	No. of cases.	Relief of pain.	Unsuccessful.
Lesser curvature.	8 (1)	6	Two cases disliked tube; one was very advanced.
L.c. and gastro-jejunostomy.	2	2	—
Stomach, near pylorus.	4 (1)	3	? 1 unreliable.
Pylorus.	2 (1)	2	—
—	16	13	—

(1) X ray; localised tenderness only present.

complete relief from pain was obtained in all the 13 cases of Column 3. There may be other factors in its causation. But the patients were satisfied that the tubes were beneficial and that they often prevented the onset of pain. Of the three unsuccessful cases one was unreliable, since every two or three days fresh pains appeared in different parts of the body. One was a very advanced case of saddle-shaped ulcer of the lesser curvature found at operation; gastro-jejunostomy was not done. He disliked the gastric tube intensely, and received no benefit from it. The other patient also disliked the tube and has since improved without it.

Effect of Intragastric Pressure on Continuance of Ulceration.

So far it has been shown that pain in gastric ulcer can be produced by only moderately distending the stomach, and can be relieved by releasing the pressure. Is there any evidence that gastric pressure is responsible for the continuance of the ulcer? At present the cause of chronic gastric ulcer is a profound mystery. Clinical evidence is naturally hard to assess, and particularly in the case of gastric ulcer, which so often tends to heal of its own accord, at any rate for the time being. One of the out-patients has now for two months completely lost her gastric pain, which had recurred in July, 1920, after she had been successfully treated for it in hospital by rest in bed. The fæces now contain no occult blood. The other out-patients say they are better. Of 5 cases at present undergoing treatment in hospital 3 seem to have lost their pain completely; the other 2 still get some attacks. It is early to draw conclusions.

It will, however, be worth while to consider other evidence bearing on this point. Bolton² found experimentally that if gastro-toxic serum was used it was the HCl of the stomach that was responsible for the formation of the acute ulcer, which could be completely prevented if the stomach contained alkali. It is reasonable to look upon the HCl as an important factor in the causation of human peptic ulcer. But Bolton found it was not at all easy to produce an experimental chronic ulcer. The acute ulcer healed readily whether the stomach contained food soaked with acid or alkali, whether it was infected by bacterial cultures, or whether the animal was rendered anæmic. The only way to hinder the healing was to give meat instead of milk, or to produce artificially some degree of pyloric stenosis. These factors would both tend to cause a retention of food in the stomach; but they would also both lead to increased gastric pressure.

Bolton describes the shape of his experimental ulcers as that of a funnel or some modification of a funnel. Ulcers as seen by X rays often appear as funnel-shaped projections, and at other times present the form of sacs. These shapes can be explained on the intragastric pressure hypothesis; but Bolton's explanation, that they are due to action of the gastric juice, is not very satisfactory, because the latter would act evenly over the whole surface and not eat away more in the middle of the ulcer.

Bolton describes the experimental ulcer which is adherent to the pancreas as having a flat base, and

suggests that this is due to some special resisting power on the part of the pancreas. But such a hypothesis is unnecessary if intragastric pressure is the cause, since the pancreas is a firm organ, while in most other positions the ulcer projects out against yielding coils of intestine. Gastric ulcers at post-mortem are usually described as having flat bases; but it does not follow that this is their shape during life inside the body.

The hydrochloric acid of the stomach has been considered to be the cause of chronic gastric ulcer, but while its concentration is usually increased in pyloric and duodenal ulcers, it may be quite low with ulcers in the body of the stomach, as has been pointed out by Bolton. Again, in two cases of ulcer on the lesser curvature, one recurring after gastro-jejunostomy, the test meal showed absence of free HCl, while in these cases a rise of pressure was obtained on passing air into the stomach, showing that the opening did not always remain patent. In both cases, however, food was seen to leave the stomach rapidly (see Cases 5 and 6).

It is possible to explain the beneficial effects of gastro-jejunostomy by the release of pressure, but it is not generally realised with what dramatic suddenness complete relief from pain may be achieved by this operation. In two cases of chronic ulcer of the lesser curvature, one associated with considerable gastric delay, the patients complained of intense pain while at rest in bed, in spite of dieting, and it was only possible to relieve this by morphia. Mr. R. Davies-Colley performed gastro-jejunostomy. Pain was completely relieved at once. It was in reflecting on these cases, and after a conversation with Mr. E. G. Slesinger about his work with Dr. Hurst, that the possible use of gastric and gastro-duodenal tubes suggested itself to the writer.

The perforation of a gastric ulcer may be due to acute distension of the stomach (Case 5). The patient states that for some weeks before perforation occurred she suffered from the most severe pains with wind, culminating in the final excruciating paroxysm when the ulcer perforated.

In 1918 the writer performed a post-mortem examination on a patient who had died of pneumonia about three weeks after an operation for chronic gastric ulcer on the lesser curvature. In this case the ulcer had been excised but no gastro-jejunostomy had been done, and the pylorus had been left intact. At the post-mortem examination it was found that the stitches had given way, and that the ulcer had re-formed in the middle of the incision. This can be explained on the hypothesis that the intragastric pressure had not been relieved.

Lavage has been frequently performed with benefit in the past for gastric ulcer. In a South African patient in whom the presence of gastric ulcer was proved by means of X rays Dr. Fouché prescribed lavage. The patient subsequently informed him that she found it unnecessary to wash out the stomach. The presence of the tube alone was quite enough to abolish the pain.

The writer wishes to express his best thanks to Dr. French and to the authorities of Lambeth Infirmary for facilities for investigating certain of their cases.

Conclusions.

1. An important element in the pain of gastric ulcer is due to distension of the stomach, and can be relieved by means of gastric and gastro-duodenal tubes.

2. Some evidence has been brought forward that chronic gastric ulcer is due to intragastric pressure.

References.—1. Hurst: *The Sensibility of the Alimentary Canal*, Oxford, 1911. 2. Bolton: *Ulcer of the Stomach*, London, 1913; *Proc. Roy. Soc.*, 1907, B. 79, p. 533; *Proc. Roy. Soc.*, 1910, B. 82, p. 233; *Journ. Bact. and Path.*, xiv., p. 424. 3. Hurst, Cook, and Slesinger: *Journ. Physiol.*, 1908, xxxvii., p. 481.

BRISTOL DISPENSARY.—The annual report of the Bristol Dispensary states that during 1920 the patients treated reached the record number of 10,324. The expenditure unfortunately exceeded the income. Dr. R. Shingleton Smith, honorary consulting physician to the institution, whose active interest has for many years been unstintingly placed at the service of the charity, has resigned from the committee owing to ill-health.