this holds good in the case of infections by the pneumococcus, and particularly those which are localised and are associated with pus formation. Cases such as these have yielded most promising results and I could cite numerous instances. I have, however, selected two which will suffice to show the possibilities of this adjunct to ordinary operative procedures.

The first (Chart 4) was a small girl in whom double lobar pneumonia was followed by empyemata, that on one side being opened on the twentieth day of the disease and on the other two days later. A subcutaneous (pneumococcic) abscess of the arm was also opened on the twenty-second day. The right hip, the seat of suppurative arthritis, was operated upon on the thirtieth day and an iliac abscess also was drained. On the fifty-fourth day an abscess in the gluteal muscles, behind the trochanter, was incised. A vaccine was prepared from a pneumococcus isolated from the empyema pus and treatment was commenced on the fifty-second day. The effect of the injections upon the temperature is well seen, and the case, which had been regarded as hopeless, was discharged to a convalescent home on the eighty-second day. The next case (Chart 5) suggests the point I have already referred to concerning particular varieties of pneumococci against which certain antipneumococcic serums were powerless. The boy was under treatment for tuberculous peritonitis complicated by a secondary pneumococcic infection, and pus crowded with pneumococci was discharged freely through the ruptured umbilicus. On the twenty-second day after the patient's admission to hospital and again on the thirty-third a "stock" pneumococcus vaccine was injected but without obvious effect so far as concerned either temperature or general clinical condition. A vaccine was then prepared from the particular pneumococcus isolated from the peritoneal pus of this patient and improvement followed the injection of a dose on the forty-fourth day. The improvement was continued, the patient put on weight, the pus gradually disappeared, and the temperature came down. Tuberculin treatment was then adopted and the patient after a short stay in a convalescent home will become an out-patient.

One other application of pneumococcus vaccines to cases in which operative treatment is needed—and these remarks hold equally in the case of other bacterial infections—and I have done. Where the opsonin content of the blood is low the preliminary injection of a suitable vaccine by stimulating the manufacture of further supplies places the patient in the most favourable condition to withstand shock and resist the further spread of infection through the disturbance of the tissues involved by the necessary operative procedures. In illustration I might mention a case of empyema and peritonitis following lobar pneumonia in an adult female under the care of Dr. W. Hale White. From the pus, the fluid portion of which had an opsonic index of less than 0.2, a virulent pneumococcus was isolated, a vaccine prepared, and a dose injected. Two days later the empyema was opened, when it was found that the pleural cavity communicated with the abdominal cavity and some five or six pints of pus were removed. The index of the liquor puris was now 0.9. The patient convalesced rapidly—a few more injections of vaccine were required—and was discharged cured.

CONSIDERATIONS CONCERNING THE FUNCTIONS OF THE STOMACH AND THE OPERATION OF GASTRO-ENTEROSTOMY.

BY H. M. W. GRAY, F.R.C.S. EDIN.,

SURGEON AND LECTURER ON CLINICAL SURGERY, ABERDEEN ROYAL INFIRMARY.

ON account of the usually immediate and striking benefit obtained, the operation of gastro-enterostomy has established itself as a very valuable and necessary procedure in many diseases involving the stomach and duodenum. Nevertheless, in spite of careful selection of cases, disappointing results, such as regurgitant biliary vomiting or formation of jejunal ulcer perhaps with perforation, occur occasionally, even when the most modern method (posterior no-loop) has been followed. Why such sequelæ should occur only occasionally, when apparently the same technique has been carried out as in perfectly successful cases, is not clear. A possible

explanation may be that sufficient care is not taken in the selection of the site of the opening in the stomach. Mayo's guide (that the opening should lie in a vertical line from the cardiac orifice) is probably a thoroughly sound one when the stomach is lying undisturbed in the abdominal cavity. When the stomach is pulled out, however, or otherwise manipulated the proper place may not be chosen, as the organ tends to swing round its lesser curvature. This, as I shall endeavour to show, may be the reason of untoward results.

The best operative procedure is that which most nearly preserves or restores the natural functions of any part requiring such interference. For this, of course, accurate knowledge of the natural functions of the part concerned is necessary. I venture to assert that this essential is not fulfilled in the case of the stomach, at least in so far as its motor functions are concerned.

It would seem that gastric surgery, as developed from experience gained in earlier operations on greatly dilated stomachs, has persisted in regarding the stomach as a "one compartment" organ. (Fig. 1.) Operations were

FIG. 1.

Tracing of stomach figured by W. J. Mayo in article on the Technique of Gastro-enterostomy in the *Annals of Surgery*, April, 1906 (reduced to one-third). a, Cardiac orifice; b, pyloric orifice.

planned with the object of "draining" these huge stomachs. To suit latter-day ideas some other term than "drainage" must be found. It does not convey a proper idea of the modern operation, which is executed more on the principle of a "short circuit" or, in some cases, of a "safety valve." Cannon and Blake¹ showed that gastro-enterostomy need not be a drainage operation; that, in fact, food preferred to pass through the pylorus rather than through the newly formed "stoma," unless the latter was made very large. Their observations have probably been too much emphasised in this connexion. They were made on normal healthy cats. Leggett and Maury's² more recent experiments prove little. Most of their operations, recorded in detail, seem to have resulted, more or less, in the old "vicious circle."

To procure its beneficial results gastro-enterostomy must be at first a drainage operation; later, when the gastric secretions and the condition of the pyloric sphincter and of the neighbouring mucous membranes have become more normal, this function of drainage is not required and food may again pass naturally through the pylorus. Where permanent pyloric or duodenal stenosis is present, then, of course, "drainage" is permanent. Cannon and Blake³ have shown that towards the end of digestion the pyloric end of the stomach is the lowest part, owing to the contraction of the longitudinal fibres of the stomach, and therefore that the "stoma" in gastro-enterostomy should be made as near the pylorus as possible. This seems rather at variance with their finding, that the operation is not a drainage one, and I shall endeavour to show that there are probably more potent reasons why the "stoma" should be made as near the pylorus as possible. The great reason is that by making the stoma in this situation gastric digestion is allowed to become more quickly and permanently normal again.

Professor D. J. Cunningham,⁴ the late Professor Birmingham,⁵ and others have shown very conclusively in anatomical specimens that the shape of the stomach is very different from that described until a few years ago. It is evident

¹ *Annals of Surgery*, May, 1905.

² *Ibid.*, October, 1907.

³ *Loc. cit.*

⁴ *Transactions of the Royal Society of Edinburgh*, vol. xlv., Part I., No. 2.

⁵ Cunningham's *Text-book of Anatomy*, second edition, p. 1052.

that it can no longer be regarded as a "one compartment" organ. (I am very greatly indebted to Professor Cunningham for permission to publish several of his illustrations. I should like to say that practically the whole of this paper had been written before I knew of Professor Cunningham's excellent work, and I was gratified to find that his anatomical observations supported so strongly the deductions I had made from personal clinical observations.) Tracings of x ray shadows of the stomach of "normal" individuals who have taken meals mixed with bismuth subnitrate, made by Cannon and Blake⁶ and lately by Pfahler,⁷ show the differentiation indicated so well by Professor Cunningham, although these authors do not point this out. The "normal" stomach when at rest—i.e., empty—appears, to judge from these anatomical studies, to be tubular in nearly its whole extent, the exception being the proximal, larger part of the cardiac end, which never loses a more or less saccular form. Judging from what one sees on "screening" a stomach which is disposing of a bismuth meal this *normal* form becomes even more marked than in the resting state. This *normal* form of the stomach is seen in its most perfect condition in the stomach of the foetus before term. (See Figs. 2, 3, and 4.)

FIG. 2.

"Stomach of a full-time foetus, showing the physiological subdivision into a cardiac saccular portion and a tubular portion." (Cunningham.)

FIG. 3.

"Stomach of a full-time foetus in which the physiological division into two parts is seen." (Cunningham.)

FIG. 4.

Tracings of (a) foetal stomach at fourth month, and (b) foetal stomach at full term. Cardiac portion distended with amniotic fluid, &c.; P, pylorus. From specimens in the Anatomical Department of Aberdeen University.

Having been impressed (from clinical observations) with the idea that the adult human stomach in its natural state should more or less conform to this type, I naturally looked

for confirmation in the formalin-hardened stomachs investigated by Professor Cunningham, and, to my mind, it is not wanting. One must remember, in looking at his illustrations, that the hardening fluid was probably never injected earlier than 24 hours after death. By this time gas formation occurs. This causes irregular relaxation of the gastric walls. In one case one part dilates while another remains contracted; in another case the reverse occurs, and so on. The onset of

FIG. 5.

"Stomach of a young male viewed from the front and slightly from above." "From its form we may conclude that at the time of death the digestive process was in a state of abeyance, or was just at the point of beginning." (Cunningham.) May not the form be more likely due to excessive ante- or post-mortem dilatation?

FIG. 6.

"Stomach of an adult female in the early stage of the emptying process." (Cunningham.)

FIG. 7.

"Stomach of an adult male showing very clearly the physiological sub-division into a cardiac sac and a gastric tube." "B.S., Part of gastric tube formed by the body of the stomach." (Cunningham.)

death and the loss of contractility of unstriated muscle, in the case of arteries, varies with the condition of the individual's nutrition at death. This rule, no doubt, applies also to the unstriated muscle of the alimentary canal and must be taken into account when such observations are made. Thus an average must be struck in order to arrive at an approximately

⁶ Ibid.

⁷ Journal of the American Medical Association, Dec. 21st, 1907.

accurate knowledge of the condition of affairs. One expects, of course, that where circular muscular fibres preponderate, there constriction will more frequently be present. By making a composite picture therefore of the illustrations presented by Professor Cunningham one finds that the foetal form asserts itself. (Figs. 5 to 11.) Observations on the stomach form (such as those made by Wernstedt⁸) when

FIG. 8.

"Stomach of a young adult male viewed from above, in which the emptying process is nearly completed." (Cunningham.)

FIG. 9.

"Stomach of an adult female; aberrant form." (Cunningham.) May not this be merely modified by post-mortem dilatation?

FIG. 10.

"Stomach of an adult male; aberrant form." (Cunningham.)

even artificial distension (*künstliche Dilatierung*) was often made previously to the hardening process are obviously of no value in settling this question.

FIG. 11.

"Specimen obtained from the post-mortem room. It exhibits a form intermediate between that seen in Fig. 7 and that of a true hour-glass stomach." (Cunningham.) Might not post-mortem dilatation explain the difference in appearance?

The stomach is divided by the so-called "incisura angularis" (His), on the lesser curvature, into a more or less vertical cardiac part, to the left, and a horizontal pyloric part to the right. As stated, the proximal part of the cardiac portion is always sac-like. The distal part is well supplied with circular fibres. Into the far end of this numerous bands of oblique fibres run from the cardiac orifice (Fig. 14), reaching to the greater curvature opposite the incisura angularis. These are quite well marked and have no doubt a definite function to perform. This tubular (?) cardiac part deserves greater attention than it has hitherto received, as it is probably in it that most important preliminary "churning" of the food takes place. (Figs. 12 and 13.) The food is thus thoroughly mixed with the cardiac juices before being passed into the pyloric part. The "incisura angularis" corresponds in many specimens with a well-marked set of circular fibres (Figs. 12 and 13) previously known, by physiologists especially, as the "sphincter of the antrum" or the "transverse band." According to Starling⁹ this is a physiological and not an anatomical sphincter. I suggest that "*sphincter aditus vestibuli*" is a more suitable name. The pyloric portion of the stomach is subdivided by a slightly marked sulcus on

FIG. 12.

"Section through the stomach of an adult male (aberrant form) along the plane of the curvatures." (Cunningham.)

the greater curvature into a larger part, the *pyloric vestibule*, and a smaller, very muscular part, the *pyloric canal*.

The proximal sac-like part of the cardiac portion is endowed apparently only with tonic contraction. The more

⁸ Archiv für Anatomie und Physiologie (Anatomische Abtheilung), 1907.

⁹ Recent Advances in the Physiology of Digestion, by E. H. Starling, 1906, p. 134.

tubular distal part is capable of peristaltic action as well (Figs. 12 and 13). The action of the oblique fibres (Fig. 14) would materially aid the sphincter aditus vestibuli. The pyloric part of the stomach is normally tubular, tonically contracted, and at certain stages of gastric digestion affected by strong peristaltic waves which increase in

FIG. 13.

"The anterior half of the stomach depicted in Fig. 11."
(Cunningham).

strength as the pylorus is approached, corresponding to the increasing amount of circular muscular tissue present. All this is easily confirmed by the use of x ray screening after a "bismuth" meal. The meal (containing from 1½ to 2 ounces of bismuth subcarb.) should be taken in two or three "courses" at intervals of from 15 to 30 minutes.

The pyloric portion, as I shall point out again later, thus resembles a much-hypertrophied piece of intestine, the hypertrophy becoming more marked as the pylorus is neared. There is no good reason for thinking that reversed peristalsis should occur here any more than in the small intestine. If the pylorus is closed an axial reflux stream

FIG. 14.

"This figure shows the muscular fibres of the anterior half of the stomach represented in Fig. 10. The mucous membrane and submucous coat have been removed from the interior." (Cunningham.)

takes place (not necessarily back into the cardiac end).¹⁰ Yet the common idea seems to be that food is tossed or churned backwards and forwards in the stomach as a whole. It may quite reasonably be supposed that when food enters the easily dilated cardiac portion it becomes mixed with "juices" secreted there and is passed on from one compartment to another as soon as it is suitably prepared. If too much food is introduced some of it is ejected (vomited)—e.g., in the presumably normal stomach of the infant. If unsuitable food is taken abnormal secretion occurs—e.g., too much acid. This may be neutralised in the pyloric portion; if not, the pylorus is irritated and remains contracted, regurgitation into the cardiac end occurs, and a "vicious circle" is established and maintained till the stomach is emptied by vomiting and a fresh start can be made. This very readily occurs in the infant. In these modern days, as the individual grows older, the stomach becomes increasingly abused, the "natural" state of things is changed, and a larger and larger part of the cardiac end goes to form the passive reservoir. When the cycle of events has led to actual disease (ulceration, pyloric spasm, stenosis, &c.) more and more of the stomach is involved till it assumes the condition of a large flaccid bag which has little power of emptying itself. There are nowadays very few normal stomachs to be found. In fact, it is probable that the "normal" condition in the adult is, as I have indicated, a rather feebly acting cardiac bag and a more forcibly acting, but still too frequently relaxed, pyloric tube. Such an organ is very easily upset in its digestive powers.

The juices secreted by the different parts of the alimentary tract interact upon one another, stimulating or inhibiting. For example, as Wertheimer and others have shown, acid in the duodenum excites the production of secretin, which in turn stimulates the secretion of pancreatic juice. This observation applies apparently to the greater part of the small intestine, although the response is more feeble in the lower parts. On the other hand, according to some authorities, secretin or some other substance in the small intestine exerts an inhibitory effect on the secretion of the gastric (acid) juice. If, then, owing to hyperacidity, pyloric spasm occurs the gastric juice cannot gain access at the proper time to the small intestine and the cycle of events referred to is broken. The effect of gastro-enterostomy, by draining the pyloric portion through the short circuit, is to act as a safety valve. A more probable explanation, in the light of the opinion of the greater number of physiologists, is the following. In a case, for example, of hyperacidity causing pyloric spasm mere drainage of the pyloric portion removes foodstuffs which serve as a chemical stimulus in the production of acid and also provides for easy escape of the excess of acid tending to be present. Therefore the hyperacidity will be reduced and consequently the pyloric spasm. As Starling¹¹ remarks: "The juice secreted in the second phase must vary according to the quantity of gastric hormone produced in the pyloric mucous membrane, and therefore with the nature and amount of the substances produced in the preliminary digestion of the gastric contents by means of the psychic juice. . . . The second phase of secretion will continue so long as there are substances present in the stomach to act upon the pyloric mucous membrane." Draining off these will necessarily diminish the production of juice.

¹⁰ Since this paper was submitted for the acceptance of the Editor of THE LANCET I have read with great interest the valuable article in the *British Medical Journal* of Jan. 18th, 1903, p. 134, by Dr. A. F. Hertz. I quote one paragraph which has a very direct bearing on what I have said: "No mixing of the contents of the two parts of the stomach occurs. Thus, on a number of occasions I have observed that if food mixed with bismuth carbonate is eaten shortly after a meal containing none of the salt, a rounded shadow just under the left half of the diaphragm is seen, whilst the pyloric part of the stomach remains invisible. After some time the first part of the meal passes into the duodenum, and the food containing the bismuth gradually replaces it in the pyloric part of the stomach, which therefore becomes visible."

¹¹ Loc. cit., pp. 78, 79.

I feel that this view of the anatomical arrangement of the adult stomach is the right one owing to the fact that I have so frequently observed this condition of affairs during operations on or near the stomach. As I have stated already, one finds that, unless the stomach is much dilated as a whole,

FIG. 15.

FIG. 16.

FIG. 17.

Outlines of three stomachs, removed post mortem, collapsed and flat on a plate. In spite of considerable distension having been present, they manifest a distinct tendency to form a cardiac sac and pyloric tube. There was no evidence of disease in stomach or duodenum of either case. Observed, without selection, by Dr. G. M. Duncan, Pathological Department, Aberdeen University.

the pyloric part when exposed, and especially if handled, looks like a piece of much hypertrophied intestine. This part presents in a median epigastric incision. The cardiac part is usually flaccid. In cases where gastro-enterostomy has been indicated I have found it enlarged as well as flaccid. Indeed, the presence of this *flaccid enlargement* may be an indication that gastro-enterostomy will do good, even although no pyloric stenosis exists. This cardiac portion does not appear in the wound, but when pulled out makes a striking contrast to the contracted pyloric part and offers great temptation to those who believe in the "drainage" qualifications of gastro-enterostomy, to make the stoma at the most dependent part of the flaccid bag. Moynihan¹² refers to repeated observations of localised spasmodic constrictions "in the body of the stomach and at the pylorus, but never at the fundus." These I have also observed. They are, of course, quite different from the general contraction of the pyloric portion which I have just described. In fact, they may occur along with this, especially if the stomach be mechanically irritated.

It seems to me that our ideas as to what constitutes pathological dilatation of the stomach must be revised. Without doubt such dilatation occurs first in the cardiac end and may be the cause of such persistent symptoms as only operation will satisfactorily get rid of. Our present diagnostic methods of inflating the stomach are ordinarily probably too vigorous and too much attention is given to the relation of the stomach (the pyloric portion, which may still be approximately normal) to the umbilicus. Unless gastric resonance, as ascertained in the neighbourhood of the mid-line of the abdomen, reaches nearly to, or beyond, the umbilicus, there is thought to be no dilatation of the stomach. From practical experience I feel sure that more attention should be given to the condition of the outline of the cardiac portion. Careful external examination will often reveal an unexpected amount of dilatation there. The more natural the stomach the more decidedly is it in the form of "cardiac sac and pyloric tube." This may prove of much value in diagnosis.

In order to explain satisfactorily the symptoms of gastric ulcer and the beneficial effects of gastro-enterostomy the cycle of events in the stomach at work must be somewhat as follows. The cardiac portion acts as a reservoir, in which food is, in a great measure, prepared for further digestion by being subjected to the action of the juices secreted in that part. The food is intimately mixed with those juices by the churning action of the gastric muscular coats, especially of the distal part of the cardiac portion, and by the movements of the diaphragm and abdominal muscles during respiration and conversation, and still more so during forced respiratory movements, such as laughing, sneezing, and the like. (This can be confirmed by screening after a bismuth meal.) Hence we have possibly a partial scientific explanation of the adage, "laugh and grow fat," and of the custom still extant in some quarters of passing round the snuff-mull at the end of a meal. These movements, moreover, assist the circulation of the blood in the abdominal cavity and thereby are beneficial to digestion. The food, having acquired its proper chemical reaction, is now (after from 15 minutes to half an hour, according to the nature of the food), by the drawing up of the greater curvature (Cannon), propelled into the pyloric portion which, by its marked peristaltic efforts, thrusts the food towards and through the pyloric sphincter. Skiagraphic tracings of the human "normal" stomach (e.g., Pfahler's) show that the part well to the left of the mid-line is filled with food first (i.e., the saccular and tubular parts of the cardiac portion—the vertical portion of the stomach). This can easily be confirmed. Even when a considerable quantity of food has been swallowed, causing a fair amount of distension, the vertical cardiac portion is still alone affected. It would seem probable that until the time when the drawing up of the greater curvature takes place there is no food or acid secretion in the pyloric part, ingress of such being prevented by its tonic contraction and higher elevation and the closure of the "sphincter aditus vestibuli" (tucked up by the action of the oblique fibres). A well-marked notch can frequently be seen (with the fluorescent screen) on the greater curvature, corresponding to the position of this sphincter, after part of the "bismuth" meal has passed into the pyloric portion.

The pyloric portion resembles the duodenum in its pathology. The reaction of its secretion is alkaline. Its

secretion is profuse and renders the chyme more fluid. Hyperacidity of the gastric contents causes irritation or ulceration, especially if they are retained long in this portion by spasm of the pylorus. The pyloric secretion may be insufficient to neutralise this hyperacidity and make the chyme of a proper reaction to stimulate relaxation of the pylorus. Exacerbation of the pain in gastric ulcer is due to irritation thereof by food, acid, or more or less by increased movement. In support of the foregoing statement (at the end of the last paragraph) I point out that the pain of ulcer of the pyloric region does not assert itself until a considerable interval after food is taken into the stomach, i.e., until some part of it, first rendered acid, has gained access to the pyloric part. If the pain is due to increased movement of the pyloric part, then this portion must be at rest during the earlier stage of gastric digestion (tonically contracted).

It seems that the mechanical functions of the stomach, as hitherto understood, have been deduced (1) from imperfect anatomical knowledge; (2) from direct observation (Rossbach) perforce made under abnormal conditions; (3) from chemical tests made with substances which are absorbed only when they reach the duodenum; (4) from the persistence in the stomach after varying periods of indigestible particles or ordinary food-stuffs introduced; and (5), possibly most important, from x ray screening of the stomach after a meal mixed with bismuth. Of these, only (2) and (5) may throw light on the action of the pyloric portion; (3) and (4) have reference to the action of the stomach as a "one compartment" organ. With regard to Rossbach's observations, as already stated, one often sees contraction of the pyloric portion in a fasting stomach exposed during operation. The churning action, observed at an early stage and attributed by some x-ray observers to the pyloric portion, is apparently confined to the part of the cardiac portion adjacent to the "sphincter aditus vestibuli," which is possessed of peristaltic action.

Physiologists state that the "two portions of the stomach seem to be partially or, in certain animals from time to time, completely cut off from each other by the contraction of the sphincter of the antrum" (Stewart). The part distal to this "sphincter" is in the living stomach tubular (Starling). An obvious difference in colour of the parts of the stomach is apparent in such an animal as the rat. This is sharply demarcated.

Developmentally, the greater part of the cardiac end of the adult stomach is a mere diverticulum, blown out, as it were, from one side of the gastric tube, although it is the most important part of the tube from the standpoint of the gastric digestion.

The predisposition of the pyloric portion to ulceration as compared with the cardiac end has already been referred to. The constriction in cicatricial hour-glass stomach usually occupies the site of the "sphincter aditus vestibuli." The part of the cardiac portion adjacent to the lesser curvature (the remnant of the gastric tube from which the cardiac diverticulum is developed) is to be differentiated from the rest of the cardiac portion. It resembles the pyloric portion and is the usual site of ulceration when this involves the cardiac end.

Thus developmentally, anatomically, physiologically, and pathologically, there are great differences between the pyloric and cardiac ends of the stomach.

Taking these differences into consideration, it seems extraordinary that the stomach should be looked upon, for working purposes, as a "one compartment" organ. Indeed, it seems absurd to suppose that food was meant to be tossed about inside an organ which pours out acid secretion at one end and alkaline secretion at the other end. It would be folly to think that the one type of secretion does not inhibit the action of the other by mere neutralisation alone. That a gourmand escapes extreme digestive disturbance even although he daily distends his stomach so that cardiac and pyloric portions form one cavity, proves merely the extraordinary accommodative power of the human alimentary tract—it does not disprove the theory I put forward. It is apparent even to the most unobservant layman that he is the healthiest when he eats sparingly.

When the importance of all these points has been appreciated it seems to me that in performing gastro-enterostomy one must endeavour to preserve as nearly as possible the natural condition of things. Finney's operation (an extensive pyloroplasty) fulfils best this desideratum, but it is by no means always applicable. The fact that Finney's operation is productive of such good results in suitable cases lends great support to what I say.

The opening in the operation of gastro-enterostomy must be made as near the pylorus as will permit of a "comfortable" position of the duodeno-jejunal portion to be anastomosed. By fixing this portion to the stomach in a more antero-posterior line than is usually done one finds that the opening can be made an inch or two nearer the pylorus.¹³ (Of course there must be no kink formed in the upper part of the bowel.) This margin may make all the difference afterwards.

The opening should be a large one, as I think it is of great importance that it should provide "drainage," when this is necessary, not of the cardiac portion but of the pyloric portion, and thus allow exit into the jejunum of the hyper-acid gastric contents when projected into the pyloric from the cardiac end. This will at once place the pyloric end practically at rest compared with its previous restlessness in attempting to overcome the resistance of the irritated and spasmodically contracted pyloric sphincter. The tendency to prolonged acidity in the pyloric end will be neutralised by "the entrance of the alkaline pancreatic juice and bile" (Paterson).¹⁴ These two factors explain the usually immediate cessation of the severe pain of ulceration after gastro-enterostomy.

The escape of the acid chyme is not prevented by the pyloric sphincter and takes place into the jejunum through the new stoma at an early period and will stimulate pancreatic secretion at an earlier stage than previously occurred in the patient. As Mr. H. J. Paterson points out, there will then be a correspondingly earlier diminution of the gastric secretion and therefore the hyperacidity will be reduced. The early escape of foodstuffs from the stomach by diminishing normal chemical stimulus might account in large measure for this, as previously pointed out. The "abnormal excitation of the gastric mucosa which results from spasmodic stenosis of the pylorus" (Paterson) will of course be done away with.

I believe that the tonic contraction of the pyloric portion and of the sphincter aditus vestibuli is the usual and essential factor in preventing regurgitant biliary vomiting. The action of the muscular coats of this part is stronger than that of the jejunum, hence will prevent any more than a very localised escape of bile and pancreatic juice into the stomach, unless placed in such impossible conditions of vicious circle as the frequent kinking in the old loop method produced. In uncomplicated cases of gastro-enterostomy I have found, on passing the stomach tube, that bile is not present in the cardiac end of the stomach.¹⁵ If the passage of the tube causes attempts at vomiting it is quite probable that the increased intra-abdominal pressure, especially in cases where dilatation existed previously, will cause regurgitation of bile and pancreatic juice into the cardiac end. I believe that the cases of biliary vomiting which I have heard of occurring after the no-loop method are probably due to the fact that the anastomotic opening has been made in the cardiac enlargement where the bile probably causes irritation and is vomited. In certain cases, of course, it is no doubt due to malposition of the anastomosed bowel. Even when the opening has been made in the cardiac enlargement, the muscular action of the cardiac end may keep or force back bile into the jejunum and thus prevent vomiting, but in cases of atony of this part the bile and pancreatic juice may follow the line of least resistance, fill up the cardiac end, and be vomited. Mr. Moynihan's case,¹⁶ in which the whole of the bile and pancreatic juice had to pass back through the pylorus owing to the operative closure of the duodenum, does not necessarily prove that bile is non-irritating to the stomach. He does not record to what portion of the stomach the jejunum was attached—probably to the part presenting in the wound (the pyloric portion), in which case the bile would pass almost immediately into the jejunum. All the same, in many cases, "bile" in small quantity does not appear to cause irritation in the cardiac end. When fatty food is taken in excess the

¹³ On the eve of sending this paper for publication I have read Mr. B. G. A. Moynihan's article on "The Treatment of Chronic Diseases of the Stomach," Surgery, Gynaecology, and Obstetrics, January, 1908. In it he advocates this "vertical" position of the jejunal loop.

¹⁴ THE LANCET, Sept. 21st, 1907, p. 815.

¹⁵ I have obtained stomach contents (from two to four hours after a meal) from six cases operated on during the past six months. The specimens were examined by Dr. J. M. Macqueen in the Physiological Department, Aberdeen University. In five there was no trace of bile. (In one of these the attempt to pass the stomach tube caused vomiting.) In one there was a very faint trace of bile. In this case, pericolic adhesions, found at operation, may have caused slight obstruction in the efferent loop of jejunum.

¹⁶ Brit. Med. Jour., May 11th, 1901.

normal mechanism of the pyloric apparatus is evidently in abeyance. Bile and pancreatic juice are allowed to gain their way to the cardiac part in small amount, upon which the fat there is partly digested—a marvellous provision of nature for the benefit of the gourmand.

In the majority of cases I believe that the opening *is* made in the pyloric portion but, so far as I can make out, with no proper, definite precaution to attain that end. The stomach is usually pushed *down* through an opening in the mesocolon and, if the pyloric portion is contracted, the cardiac enlargement may easily be substituted for it. The plan, introduced I think by Professor H. Littlewood of Leeds, of pushing the intestine *up* through the hole in the mesocolon and making the junction with the stomach in more normal position (after tearing an opening in the omentum to get at the posterior wall of the stomach), makes it much more certain that the anastomosis is made in the pyloric portion. The thought occurs—Should one make the anastomosis in the cardiac enlargement if ulcer of the cardiac end exists, risking regurgitant vomiting, or making a Roux's (Y) operation right away? Personally, I do not think so. I have followed the usual plan in such cases of cardiac ulceration as have come under my care and the only difference I have noticed is that the pain took longer to disappear than in pyloric ulcer. The explanation of the cure is the same as in pyloric ulcer.

It is quite possible that making the anastomotic opening in the cardiac portion may explain the occurrence of jejunal ulcer after gastro-enterostomy, especially in the old loop or Y operation. The persistent trickle of acid secretion from the cardiac end compared with the intermittent ejection through the pyloric stoma may so affect a particular part of the jejunal mucosa that ulceration occurs, as the acidity is less likely to be immediately neutralised.

With regard to the effect of gastro-enterostomy on the motility of the stomach, as to whether it is a "drainage" operation, Mr. Paterson's observations,¹⁷ to my mind, prove nothing. The point is, What part of the stomach does it "drain"? A careful operator, like Mr. Paterson, is unlikely to make the opening in the cardiac enlargement and therefore in his cases food will *not* pass *at once* into the jejunum. It will, as he shows, have practically the same nutritive value. I venture to say, however, that his reasoning with regard to these facts is wrong. They do not necessarily support his contention that gastro-enterostomy is not a drainage operation. It must procure drainage or, rather, act as a short circuit or a "safety valve" before it can bring about the good effects which it does. In Cannon's observations on cats, which are so frequently referred to, in the greater number of cases the opening was evidently a small one, and food preferred to pass through the pylorus. In the only case in which the opening was without doubt a large one, food passed more readily through this opening. This is what should be aimed at in the human subject. I point out that these experiments were carried out in presumably normal animals and therefore the conditions are not comparable to those demanding gastro-enterostomy in the human patient, in whom pyloric spasm or actual stenosis compels food to pass through the new opening at all events until spasm has been relieved by more normal reaction of the gastric contents. There need be necessarily no marked effect on the emptying power of the cardiac portion when the opening in the operation of gastro-enterostomy is made in the pyloric portion. (The nutritive value of the food should then be as good as in any other individual. It may be better so far as the patient is concerned than before operation.) In the majority of operations the cardiac portion is certainly not drained, and it is into this portion that the tube is passed in order to draw off the gastric contents after a test meal. Mr. Paterson's findings appear to me to form a strong argument in favour of the "two compartment" theory I have put forward.

Results obtained with the "salol test" uphold my contentions. In repeated observations with this test, when the operation is done as I have indicated, *there is practically no departure from the normal in the results obtained.* These remarks apply as well to cases of pyloric spasm (with ulceration in the neighbourhood) as to cases of cicatricial stenosis. If gastro-enterostomy meant drainage of a "one compartment" organ, then the salol ought to reach the small intestine and hence appear in the urine at a much earlier period, especially in cases of actual pyloric stenosis.

In conclusion, I should like to say that recently I have

endeavoured to practise what I have been preaching, and the results are, to my mind, all that could be desired. Since the no-loop method was introduced the results of this operation have vastly improved, i.e., practically since the opening has *not* been made in the cardiac portion. Before the introduction of this method absence of evil results, if the Y operation was not done, was hailed with satisfaction. Now it is looked for almost with certainty. I venture to assert that with attention to the points I have mentioned fortuitous openings in the cardiac portion will be avoided and the results will be more satisfactory still.

To sum up. (1) The cardiac and pyloric portions of the stomach are distinct in development, structure, function, and pathology. (2) During the early stage of gastric digestion the pyloric portion is normally empty and tonically contracted. When food has attained a proper chemical reaction in the cardiac enlargement it passes into the pyloric portion. (3) Bearing this in mind, care should be taken in performing gastro-enterostomy to make the opening in the stomach wall within the pyloric portion, as near the pylorus as possible. This will, then, if the stomach has not irremediably lost its muscular power, provide against an "uncontrolled escape of the acid gastric contents," which is asserted by Dr. H. C. Cameron¹⁸ to occur in cases of gastro-enterostomy. If pyloric spasm be present the stoma will act as a safety-valve and remove the spasm. If pyloric stenosis exists the natural condition of things will be most nearly approached and the "regulating action" (Pawlow) of the pylorus, so necessary to perfect digestion, be most nearly approximated.

Aberdeen.

NIGHT BLINDNESS.¹

BY J. HERBERT PARSONS, D.Sc. LOND., F.R.C.S. ENG.,

ASSISTANT SURGEON TO THE HOSPITAL; ASSISTANT OPHTHALMIC SURGEON TO UNIVERSITY COLLEGE HOSPITAL; OPHTHALMIC SURGEON TO THE HOSPITAL FOR SICK CHILDREN, GREAT ORMOND-STREET, LONDON, W.C.

WHEN a patient comes to us complaining of inability to see in the dusk or in foggy weather we at once think of the disease commonly known as retinitis pigmentosa. If we were practising in India we should be much more familiar with patients complaining of this symptom and should be less likely to attach the same importance to it. There have recently been several excellent examples of retinitis pigmentosa in my clinic and you have had the opportunity of making yourselves fully acquainted with its peculiarities. It is only necessary for me, therefore, to review very briefly its principal features. The routine examination of the patient shows that there is comparatively little disturbance of central vision, though there are exceptions to this rule. Examination of the fundus shows in the early stages in young patients a zone of characteristic retinal pigmentation in the neighbourhood of the equator; both peripheral and central to this zone the retina looks almost or quite normal. I need not dwell upon the striking characters of the pigmentation—the spots shaped like bone corpuscles and the aggregations along the perivascular sheaths of the retinal vessels. At this stage we may expect to find a ring scotoma on examination of the field of vision. My senior clinical assistant, Mr. M. L. Hepburn, has recently devoted much attention to the nature of this scotoma and has shown amongst other points that it is seldom complete, but is dotted over with areas in which vision is only partially lost. Probably these areas are closely related to the distribution of the vessels, but for an exhaustive discussion of the subject I must refer you to Mr. Hepburn's admirable paper in the last number of the Hospital Reports. At a later stage the zone of pigmentation has extended both peripherally and centrally, and the field now shows uniform contraction, the peripheral area of vision having become abolished. The progress is usually very slow and central vision is seldom lost by the extension of the choroïdo-retinal disease to the macular area. Before this occurs a posterior cortical opacity appears in the lens, which, however, has much the same effect upon the visual acuity. This so-called idiopathic retinitis pigmentosa is a progressive form of chronic night blindness. It is an obscure disease in which heredity and the consanguinity

¹⁸ Brit. Med. Jour., Jan. 18th, 1908.

¹ From a clinical lecture delivered at the Royal London (Moorfields) Ophthalmic Hospital on Feb. 1st, 1908.

¹⁷ Loc. cit.