immediate past, and if I have failed to read aright the indications of the lines on which our medical schools are to advance, it must be remembered that the development of a biological science and of its dependent arts not infrequently takes place in totally unexpected directions, thus introducing into the path of educational progress perturbations which may well defy prediction.

PERFORATING ULCER OF THE DUODENUM.¹

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THE interest that has been lately directed toward the surgical treatment of gastric perforations has also been turned to the operative relief of the allied round or peptic ulcer of the duodenum. This affection is much rarer than the ulcer of the stomach, is much more difficult to properly diagnosticate and is more apt to be confounded with other more distant surgical lesions, such as appendicitis, etc.

Site.—Its site is in the upper part of the duodenum, and according to Morot² and Vonwyl³ it is always situated within 1.5 inches of the pylorus; but Schwartz⁴ gives one case where the perforation existed on a level with or a little below the ampulla of Vater and thus allowed a free escape of bile into the peritoneal cavity. The figures given by recent authorities show that in the 262 collected cases of Collin⁵ the perforation occurred 242 times within 2 inches of the pylorus, in the descending portion 14 times, in front of the aorta 3 times and in the ascending portion 3 times. Or, expressing the same a little differently, 162 of the 262 cases were situated at 2 to 4 millimetres from the pylorus; 75 close to it; 4 encroached on the pylorus itself, and two extended through pylorus to duodenum and to the stomach. Perry and Shaw have reported in *Guy's Hospital Reports*, of 1894, 141 cases of duodenal ulcer, 123 in the first part of the duodenum, 16 in the second part and only 2 in the third part.

Number.—These ulcerations are usually single. Collin says that one ulcer was found in 80 per cent. of his cases; two ulcers in 11 per cent.; and three or four ulcers in 4 per cent. Morot, in 22 cases, found 18 had a single ulcer; 2, two ulcers; 1, three ulcers and 1, four ulcers.

Location.—These perforations are encountered most frequently on the anterior wall. Oppenheimer⁶ in 15 cases noted that the perforation had taken place in the anterior wall 11 times; 3 times posteriorly and once superiorly. Of the 119 cases of Collin in which the first portion of the duodenum was perforated, in 68 it occurred on the anterior wall of the bowel; in 39 the posterior wall; in 10 the superior, and in 1 the inferior portion. In 8 ulcers perforating in the second portion of the bowel, 5 occurred in the internal wall, 2 in the posterior and 1 in the external wall; and in the ulcers presenting in the third part of the duodenum, 4 in number, in 3 the anterior and superior walls were involved, and in 1 the posterior wall.

¹ The Presidential Address in Surgery delivered before the American Surgical Association, Washington, May 1, 1900.

² Thèse de Paris, 1892.

³ Ulcer Perforans Duodeni. Thèse de Paris, 1893.

⁴ Ulcère perforante du duodenum. Bull. et Mem. Soc. de Chirurg., January, 1898.

⁵ Thèse de Paris, 1894.

⁶ Das Ulcers Pepticum Duodenale. Thesis, 1891.

This is of considerable surgical importance. The anterior perforations are, for obvious anatomical reasons, less likely to be closed off by adhesions, and hence a free and rapid involvement of the peritoneal cavity takes place in the openings here situated. Reckmann⁷ states that half the cases of duodenal ulcer die from perforation into the peritoneal cavity.

Frequency of perforation.—Perforation is said to take place 180 times in Collin's 262 cases, or in 69 per cent. Chvostek, however, places the frequency of perforation at about 42 per cent. of the cases. In these 262 cases there was a generally diffused and fatal peritonitis 125 times. But occasionally in anterior openings, but more commonly with the perforations existing elsewhere, adhesions or ulcerations with abscess and hemorrhage of the duodenal wall or adjacent organs have been encountered. Examples of such complicating lesions are subphrenic abscess, which follows more commonly a perforation in the superior wall of the horizontal portion of the duodenum (according to Oppenheimer). Liver and pancreatic adhesions are at times met with (Oppenheimer gives 6 cases and Collin 38 cases of such adhesions). Perforations into the gall-bladder have been reported, but more important and dangerous are the ulcerations into the aorta (Stich,⁸ 2 cases), or the vena porta (2 cases, Rayer and Habershon), or the superior mesenteric vein (Warfinger), or the hepatic artery (Vonwyl). The ulceration has been also known to invade the adjacent colon (2 cases, Murchison and Saunderson).

Sex.—Duodenal perforations are more common in men than in women; about 79 per cent., according to Collin, are in males. From the tables of Morot, Kraus, Lebert and Chvostek I have gathered 176 cases of duodenal ulcers, and of these 144 were in men and 30 in women.

Cause.—This has been explained by Boas⁹ to be due to the rougher food, and, in men, to their addiction to alcohol and tobacco, which intensify the acidity of the gastric juice and thus act unduly on the glandular mucous membrane of the duodenum, which is not protected until the alkaline bile and pancreatic fluid is poured into the intestine at the opening of Vater. Koch and Ewald by giving to animals 5 per 1,000 HCl caused duodenal ulcers to appear. Pyloric spasm, Talma states, produces necrosis and anemia of the membrane there. On the other hand, alcoholics are not found to be prone to duodenal ulcer, and though the spasms and lesions of gastric hyperacidity, which are now accepted as a causative factor of stomach ulcer, will doubtless apply in many instances to the development of a similar duodenal damage, there are other causes for duodenal ulceration to be mentioned beside the foregoing.

Burns.—The principal and best known, though now somewhat disputed, factor in their etiology is the influence of external burns. Holmes,¹⁰ for instance, states that in 125 cases of burns 16 cases of duodenal ulcer were found; Perry and Shaw in 149 cases of burns met with duodenal ulcers 5 times; and in Collin's 297 cases of duodenal ulcer he states that burns produced the ulceration in 38 instances. According to Holmes, the duodenal ulcerations after burns present themselves from the seventh to the fourteenth day, but Ponfick found in one instance a duodenal ulcer within

⁷ Ulcer Duodenale u seine Diagnose, 1893.

⁸ Deutsch. Arch. klin. Med., 1874.

⁹ Diagnostik u. Therapie der Darm Krankheiten, 1899.

¹⁰ System of Surgery, vol. 1, p. 733.

eighteen hours after the reception of the burn. Curling also had a case where symptoms of duodenal ulcer were recognized one day after the burn, and the autopsy confirmed the diagnosis.

The explanation most accepted at the present day is that this complication of a burn is due to septic infarctions such as may be developed in frost-bite, of which Billroth and Adams each cites a case, or in erysipelas 8 instances, or in tuberculosis (Latham). In the cases where trichinosis (Ebstein), or heart or kidney disease, or cirrhosis or hepatic or other carcinomata (Latham) exist, it is not quite so easy to trace the connection, though embolism even here has largely to deal with the question. The recognized explanation offered by Hunter¹¹ and often quoted seems inadequate to elucidate the relation between a cutaneous burn and a duodenal ulcer. This observer proved that in animals treated by injections of toluylendiamene the bile was so changed that when discharged into the duodenum ulcerations rapidly developed. His idea, therefore, was naturally that the alteration of the cutaneous covering so altered the bile as to beget the complicating duodenal ulcerations. Unfortunately duodenal ulcers are so rarely met with on a level with or below the bile discharge into the bowel that this at once disposes of the need of calling on the liver and pancreas as accomplices in their production. That septic infarction is the most probable cause of duodenal difficulties after burns may also be fairly inferred by the later collection of Lockwood, who in 138 cases of burns treated with more or less approach to an antiseptic idea noted the complication of duodenal ulcer in but one instance. A cancerous ulceration is almost unknown, but 4 cases (Eichert, Ewald, Schrotter and McKenzie) have been recorded.

Frequency.—A duodenal ulcer is, according to statistics, a rare lesion. Collin, whom one is compelled to quote by the worth of his collected cases, in a range of eleven years could only find 26 cases. Houze¹² in three additional years could add only 3 more cases, though Darras¹³ more than one year later found 5 others. Since attention has been given to the subject and particularly to the surgical aspect of it by the present writers in 1896, when 9 cases were reported as having undergone surgical treatment, there have been reported 41 operations for this disease.

The relative frequency as a cause of death deduced from autopsies is as follows:

Willigt . . .	1,600 sections with	74 gastric ulcers and 2 duodenal.
Stark . . .	384 " "	36 " " 3 "
Grünfeld . .	1,150 " "	124 " " 4 "
Steiner . . .	3,085 " "	89 " " 12 "
Vonwyl . . .	12,806 " "	98 " " 3 "
Latham . . .	8,192 " "	not given " " 12 "
Perry and Shaw	17,652 " "	" " " " 70 "
N. Y. Hospital		
(unpublished)	1,000 " "	" " " " 2 "
	49,369	421 108

or about .2 per cent. in frequency.

Kinnicut¹⁴ however, in 30,000 autopsies, which probably included many embraced in the above table, has given a rather higher percentage of frequency, placing it at .4 per cent. Though the proportion is a small one, stress must be laid on the fact that from 40 per cent. to 70 per cent. of these ulcers perforate, with an al-

most invariably fatal result. The relative proportion of gastric to duodenal ulcers is as 12 to 1 (Burwinkel).

Age.—As to the age at which it is most common, it is encountered at all ages. Chvostek in 87 autopsies on children under ten years of age found 5 duodenal ulcers, of which 1 was seen in a seven weeks' old child, another in a child four days old, and a third in a babe of three hours. Collin's table is the most complete in this respect, and it is here presented. In 297 cases of duodenal ulcers they were met with:

Under 10 years of age	42 times.
Between 10 and 20	24 "
" 20 " 30	43 "
" 30 " 40	52 "
" 40 " 50	46 "
" 50 " 60	41 "
" 60 " 80	28 "
" 81 " 95	3 "

Progress.—It has already been strongly stated that nearly all perforations of the duodenum will prove fatal from a generalized peritonitis unless surgical intervention should relieve the patient. What this consists of, what are its results and its difficulties, will be considered a little later. At present one must take account of the somewhat encouraging fact that all duodenal ulcers do not go into this severe complication of perforation. In 70 autopsies Perry and Shaw found decided evidences of repair in nearly 50 per cent. of the cases, and Collin also recorded 39 instances of cicatrized ulcerations. These cured ulcers may prove innocuous, but they can, as in the stomach, narrow to a dangerous degree the lumen of the intestine and even encroach upon the bile opening, or make such traction upon it as to bring about gastric and hepatic dilatations. Some of the most brilliant surgical triumphs have been obtained in relieving such obstructions, of which examples may be subsequently found in this article.

Symptoms.—The symptoms of a non-perforated duodenal ulcer are, as shown by Schwartz, frequently very slight. In 20 out of 25 instances of perforation, the patients were in apparent good health or so slightly indisposed that they had not consulted a physician. In only 5 cases were there previous stomach symptoms; of these 1 was thought to have dyspepsia, and 2 to have a gastric ulcer. In my own collection of 51 cases, treated by operation, gastric symptoms previously existed in 25 out of 34 cases.

The usual signs may be given as follows:

(1) The *pain* when characteristic occurs several hours after eating and may be slight or severe, and presents itself just below the gall-bladder, and may reach to the median line or to a level with the navel. Many times the pain is absent. Reckmann in 80 cases found 16 in which little or no pain existed. Pressure, particularly over the region to right of the twelfth thoracic vertebra, occasionally elicits pain. Swallowing of a sour lemonade or a strong alcoholic drink may arrest the pain by bringing about a pyloric contraction, but Pagenstecher¹⁵ denies the value of this test.

Vomiting is present in about 17 per cent. of the cases, but it is of reflex character. It is of diagnostic importance if, like the pain, it shows itself from an hour or so up to several hours after a meal, and the

¹⁵ Die chirurgische Behandlung des Duodenalgeschwürs. Deutsch. Zeit. f. Chir., August, 1899.

¹¹ British Medical Journal, vol. 1, p. 76, 1890.

¹² De l'ulcère perforant du duodenum. Thèse de Paris, 1896.

¹³ De la perforation de l'ulcère simple du duodenum. Thèse de Paris, 1896.

¹⁴ Jacobi: Festschrift, 1900.

matters rejected are broken-down food mixed often with bile and blood.

The right shoulder pains are noted by Schwartz as occasionally to be recognized. According to Vonwyl and Buequoy, the pains are often slight from the comparative immobility of the duodenum, and vary from queer indescribable sensations to severe radiations of distress. Vomiting, when it occurs, relieves the pain.

Jaundice, if present, which is rare, may be due to simple duodenal tumefaction or to cicatricial contraction on the papilla.

Hemorrhage is to be expected in about one-third of the cases of non-perforating ulcers. Probably it is even greater than this, as Oppenheimer found blood in the stools of one-half of his 34 cases, and Krauss says it occurs even more frequently than this ratio. This bleeding can be severe and show itself by mouth as well as per rectum. It can speedily prove fatal, as larger vessels are opened than by a gastric ulcer. Usually the blood is discharged from the bowels in a tarry condition, which bespeaks a high origin of the hemorrhage and an exposure of some duration to the action of intestinal secretions. This is spoken of as *melena*. Its color may be, however, a bright hue, and recently, with Dr. Peabody, the question of the presence of a duodenal ulcer in a patient with intestinal hemorrhage and right-sided epigastric pain and distress some time after eating, was negatively decided because the blood discharged per anum was of bright red color and unclotted. As the patient, moreover, had hemorrhoids, the possibility of this origin led to the confusion in diagnosis. This escape of fresh unchanged blood from the bowels is recognized by Vonwyl, and some emphasis should hereafter be placed on this possibility. The profusion of the hemorrhage may be much beyond that encountered in gastric ulcer, for larger vessels may be involved. Collins gives 12 instances in which the blood came from the pancreoduodenal artery; three times the gastro-epiploica dextra was opened into, twice the pancreatic artery, once the hepatic, twice the aorta, twice the vena porta, and once the superior mesenteric vein. Pagenstecher states that the ulcers on the posterior wall are more apt to bring about hemorrhage than the anterior ones, as the vessels are more abundant and larger there. Burwinkel¹⁶ says that, excepting in vicarious menstruation and typhoid fever, intestinal hemorrhage in large amounts is very rare and should excite suspicion of gastric or duodenal ulcers. This writer, in spite of all that has been advanced by Nothnagel, Ewald, Lemke, and latest of all, by Kinnicutt,¹⁷ that in the great majority of cases a differential diagnosis from gastric ulcer is impossible, claims that by a careful study of the symptoms he has been able to diagnose 5 cases of duodenal ulcers in the last few years.

Diagnosis.—The following contrasting symptoms have been grouped by Vonwyl as an aid to this end:

Gastric ulcer.—(1) More frequent in women, twenty-fifth to fiftieth year; (2) pain promptly after eating; (3) relieved by vomiting; (4) frequent bilious, mucous and food vomiting; (5) marked dyspeptic symptoms; (6) frequent bloody vomiting; (7) more seldom bloody stools.

Duodenal ulcer.—(1) Occurs most frequently in males; (2) pain in right hypochondrium or to right

of parasternal line; (3) comes on two to four hours after meals; (4) no relief by vomiting; latter not frequent; (5) bloody stools (*melena* or bright blood) more common than bloody vomiting; (6) if jaundice is present this would contribute to the diagnosis.

That medical and surgical education in this line is progressing has also been brought out in the cases of operations which form the basis of this paper. Here it will be seen that notwithstanding that the greater part of them have been treated as of appendiceal or other origin, surgeons awake to the possibilities of the case are making shrewder diagnoses, and the reproach which was good up to a year ago, that no operation for a previously recognized perforated duodenal ulcer had yet been performed, no longer holds good. It may be expected that as the detection and treatment of a perforated gastric ulcer has so rapidly and so satisfactorily progressed from 1892, when the writer was only able to add to his first operation of this kind but 4 other instances, while now over 100 cases each year are operated on with a mortality that has fallen (if operated on within twelve hours) from 39 per cent. to 17 per cent. (Keen¹⁸), that a similar improvement will take place in the recognition and proper treatment of duodenal ulcers.

The picture is a far different one when the duodenal ulcer perforates, and particularly if anteriorly, which is the most common site of this complication. Here there is usually no withholding adhesion, and a rapid invasion of the peritoneum is probable.¹⁹ If the stomach is yet filled, the extravasation may take an anatomical course somewhat in the order spoken of by Pagenstecher, and which is in accord with my own analogous clinical experience in three perforations of the gall-bladder. Fluids escaping from the duodenum or gall-passages flow at first between the liver and the colon and thence along the ascending colon sometimes to the outside of the bowel, and sometimes between the omentum and the parietal peritoneum towards the iliac fossa. From this point they may pass over to the sigmoid flexure and into the pelvis. Given, therefore, such a free course and with a plentiful pouring out of acid fermenting food and gas through a direct though small (2 to 8 millimetre) opening, the symptoms presented would naturally be severe.

Great pain is usually felt frequently at the epigastrium or to the right of this region, as was noted 26 times in 47 of my cases. It has a few times also been observed at the umbilicus and in the left side, but in 23 others of the 47 instances it was simply recorded as abdominal pain. Vomiting often follows the attack of pain. It occurred in 28 out of 34 instances. Shock is not often met with, but may be severe and fatal. Peritoneal symptoms rapidly develop, with a tendency in some cases to be localized in the upper part of the abdominal cavity and in the right side; when these signs show themselves mostly to the right and at or below the level of the umbilicus, it necessarily simulated an appendicitis. When the liver dulness has been dissipated up nearly to the mammary line, air extravasation may be suspected, and when accepted as present, it will aid in concentrating the diagnosis. This symptom of liver resonance, unless

¹⁸ British Medical Journal, June 11, 1898; Mayo: Surgery of the Stomach, Lancet, March 17, 1900.

¹⁹ It should also be remembered that generally the duodenum in its first part is free and covered by peritoneum, so that extravasation is likewise possible through a posterior perforation in this region. It is, however, in this case, more likely to enter the omental bursa (lesser omental cavity) or invade the retroperitoneal tissues.

¹⁶ Das peptische Duodenalgeschwür. Deutsch. med. Wochenschrift, December 29, 1888.

¹⁷ Jacobi: Festschrift, 1900.

marked, is so often found to be due to a distended colon that it should not be much relied on.

In considering the diagnosis of a perforated duodenal ulcer as just given, I cannot but feel that more weight and attention should be given, first, to the previous history, which shows, contrary to the opinions of many anterior observers, that in the 51 collected cases of operations for the relief of such conditions there was a history of gastric or dyspeptic symptoms given in 25 out of 34 cases where the point was noted; secondly, and also important, is the fact alluded to on a previous page that the initial or early pain was developed in 26 instances out of 47 in the epigastrium, and in the right hypochondrium 13 times. The third factor of value in the diagnosis, as well as the treatment, of the symptoms of perforation peritonitis, whether from stomach, duodenum, gall-bladder, appendix or any other part of the intestinal tract, is the prompt resort to an exploratory incision. This need of an early solution of the site of a perforation has been already shown in the cases of a gastric perforation in an article²⁰ embracing 78 cases operated for this trouble. The mortality in these cases clearly depended on whether the patient underwent surgical intervention within twenty-four hours from the inception (that is, the pain) of the perforation. This is yet more strongly marked in the latest collections of this class of troubles by Mayo,²¹ who states that in 429 cases of gastric perforations those operated on in the first twenty-four hours were 82, where 47 recovered; 35 died (a mortality of 42 per cent.); and that in operations done after that period over 70 per cent. of the cases died. In duodenal perforations the same outcome is observable. In the 51 collected cases herewith presented of duodenal perforations, there were 25 cases where the lesion was recognized and closed at the operation; of these, 13 underwent operation after thirty hours' delay and all died; 1 case, however (No. 31), recovered after a delay of two hundred and sixteen hours, but here the perforation had formed a chronic abscess and sinus. Twelve others were operated on within that time; 8 survived, giving thus only 33½ per cent. of mortality. *Only*, I say, and with much satisfaction, since it marks an improvement on the statistics of Pagenstecher, which gave a mortality of 60 per cent. in the found and sewn-up duodenal ulcers by him collected. Of equal value as illustrating the increasing alertness of the surgeon is the fact that prior to 1895, in the 20 cases reported up to that time in which laparotomy was done for duodenal perforation, in 15, or 75 per cent., the ulcer was not found; in 5, or 25 per cent., it was found and sutured. In only 2 cases, or 10 per cent., was the possibility of a duodenal perforation considered. Contrast this with the 31 cases operated on since 1895, when the surgery of gastric ulcer began to be developed. Of these 31 cases the perforation was not found in only 11 per cent. It was found and sutured in 20 cases, or 65 per cent. Its presence was considered in diagnosis in 11 cases, or 35 per cent.

Another indication showing the advance in our surgical art since attention has been directed to this lesion is the circumstance that it has been possible in 13 of the more recent instances to either arrive at a correct pre-operative diagnosis or to make the alternative diagnosis varying between a duodenal and a gas-

tric perforation. The difficulties that have been experienced are succinctly shown in the following statement:

Diagnosis wrong: Ulcer not found.		
Diagnosis as acute peritonitis	8 times.	
" appendicitis	15 "	
" intestinal obstruction or appendicitis	1 "	
" strangulated hernia	1 "	
" hydronephrosis	1 "	
		26
Diagnosis wrong: Ulcer found.		
Diagnosis as acute peritonitis	5 times.	
" intestinal obstruction	4 "	
" appendicitis	3 "	
		12
Diagnosis right or approximately so: Ulcer found.		
Diagnosis as duodenal ulcer	5 times.	
" gastric or duodenal ulcer	6 "	
" appendicitis or duodenal ulcer	2 "	
		13

Treatment. — For the treatment of a duodenal ulcer the medical means applicable to the management of a gastric ulcer also hold good. It is but seldom that surgical aid is called for before perforation has occurred, but the cases reported by Codevilla²² are of much surgical interest and instruction. This surgeon, for the relief of symptoms that fairly well pointed to an intractable duodenal ulceration, resorted to a gastro-enterostomy in 2 cases with a cure as the result of his intervention.²³ In some cases of perforation the shock and progress of the infection is so rapid as to bring about death in a few hours. Stevens²⁴ quotes a case where a fatal issue occurred within twenty-one hours after the first symptom (sudden pain) had shown itself.

Where the diagnosis has happily been narrowed down to a perforation of either the stomach, duodenum or gall-bladder, the incision to be advised is in or along the edge of the rectus muscle, 4 to 6 inches in length and starting rather low down on the abdominal wall, so as not to reach much above the liver edge but to extend far enough downward to easily get below the transverse colon, which might be necessary. Supplementing this incision in its upper third another transverse one, in the skin, to the left or toward the median line is advisable; this will permit the cross division of the fascia covering the right rectus muscle, which latter is in turn to be pulled to the left, when its posterior sheath, with the peritoneum, is also to be divided. This gives a satisfactory and largely increased exposure of the parts beneath and the subsequent suture of the upper and lower sheath of the rectus with the full replacement of the muscle adequately restores the integrity of the abdominal wall. This incision I have made many times in operations on the gall-bladder and in numerous instances of suppurating appendicitis when an increased space is needed.²⁵

If gas or food material escape when the abdomen is opened, the surgeon's action is rendered more certain, and by a rapid and thorough inspection, after wiping away any obscuring fluid, of the gall-bladder, duodenum and the anterior walls of the stomach the perforation can be disclosed. If nothing is visible in these regions, the examination of the posterior gastric wall can be accomplished by either tearing through the gas-

²² Pagenstecher: Die chirurgische Behandlung des Duodenalgeschwürs. Deutsch. Zeit. f. Chir., August, 1890.

²³ Berg and Roux also each report a case where for a duodenal ulcer with adhesion of pyloric stenosis a similar operation was done with success.

²⁴ Glasgow Medical Journal, vol. II, p. 87, 1897.

²⁵ Weir: Medical News, February 17, 1900; On an Improved Method of Operating for Acute Suppurating Appendicitis, Medical News, March, 1899.

²⁰ Weir and Foote: Medical News, April 25, 1896.

²¹ Surgery of the Stomach, Lancet, March 17, 1900.

trocolic omentum, or by turning up the omentum and large bowel and entering the lesser omental cavity through the mesentery, as in posterior gastro-enterostomy. From the lower end of this wound, which is large enough to admit the hand, the appendical region can be explored in many instances if it should be necessary, though probably if this should be involved a separate incision might be more suitable. If a duodenal perforation exists it will generally be found on the anterior wall of the duodenum as a small round opening, rarely beyond one-quarter inch in diameter, with comparatively thin edges and rarely adherent to any adjacent intestine. Gas or fluids have frequently been seen passing from the opening, and occasionally bile, which latter may also stain the peritoneal extravasation. Mayo has suggested that an acid reaction of the peritoneal effusion might help in suggesting, prior to its discovery, a gastric or duodenal opening, but as the inflammatory effusion rapidly neutralizes the stomach acidity, this will seldom be of help.

Since several of the collected cases have shown in the abdominal extravasation the presence of recognizable medicines, such as castor oil, etc., given erroneously to move the bowels, it may be considered worth while to utilize the fact, and to give prior to the operation a certain amount of methyl blue or other innocuous colored solution to aid in the detection of the opening. When found, the perforation should be closed by a double or triple row of interrupted silk sutures. No attempt should be made, in my judgment, to excise the ulcer before suturing. This takes too much time, and the results in the collected operations show that in 7 out of 9 of the successful cases suturing alone was relied upon. In 1 only was excision and suturing employed, and in 1 other case the ulcer was closed over by suturing over it the duodenum, colon and stomach. This experience is confirmed in the large number of gastric perforations that have been treated up to date.

The suggestions given by Pagenstecher in the conduction of this operation are worthy of remembrance. They are, that the fundus of the gall-bladder when distended, lies in front of the duodenum. By raising up the transverse colon, which rests somewhat in front of and below the horizontal part of the duodenum, and by drawing it forward, this portion of the intestine is immediately revealed. Crowding the stomach and pylorus to the left and a little downwards with lifting up the liver and pushing the colon down, a good view of the locality of a perforation is obtained.

The closure of the perforated intestine, however, leaves much of the battle for life unfinished. The proper and systematic cleansing of the peritoneum is of the utmost importance. If the extravasation is limited, careful wiping out of the affected portion of the peritoneal cavity, with especial attention to the retrogastric and suprahepatic spaces and to the splenic and renal region, with ample gauze drainage, will in most cases suffice better than the large warm irrigations of sterilized salt solutions, which are, I think, more suitable in extensive or general peritoneal inflammations.

For those who favor multiple incisions and large irrigations, the specific directions of Lennander²⁰ are of value. He considers in suitable cases and in patients of sufficient vitality that irrigations with water

at 40° C. (104° F.) through several incisions the best method of cleansing the peritoneal cavity. One must go carefully and methodically about the solar plexus and the diaphragm; methodically loosening adhesions, irrigating, and then wiping clean with wrung-out gauze. He begins with upper surface of liver, particularly on both sides of suspensory ligament, then passes between liver and stomach to the triangular ligament, then around cardiac portion, then between stomach and spleen, then under diaphragm to left kidney, and along spleen to ligament phrenocolicum. The division of the triangular ligament with a thermocautery has been suggested, so that one might sweep around the left lobe on both sides. He then cleans between the right kidney and liver, kidney and colon, colon and liver, next the lumbar regions and both iliac fossae, then both sides of the mesentery of the small intestine, and last the pelvis, which is often infected at the beginning of the trouble. A great quantity of hot fluid is of undoubted benefit in the pelvis.

Drains and tampons are intended to remove accumulating fluids and to shut off infected areas. Tubes surrounded by gauze are the best drains. He places sterile gauze on both sides of the suspensory ligament of the liver and between the liver and diaphragm. Drains should be placed in both lumbar regions, the left passing alongside of (better through) the phrenocolic ligament, external to the spleen, to the middle of the diaphragm. The right one passes to the duodenum. The pelvis of men is drained above the symphysis pubis, that of women through the vagina.

My own experience in the surgical treatment of duodenal perforation is confined to one case, which is briefly as follows:

Perforation of duodenal ulcer; laparotomy; suture; death.—Man, age thirty, who had previously symptoms, confusedly detailed, of gastric disturbance, but not of hematemesis, for several months, was seized four days previously with severe epigastric pain, chill, fever, repeated vomiting and great prostration. No blood expectorated or dejected. His abdomen rapidly swelled and became generally tender and painful. On entrance into the New York Hospital, April 30, 1899, nothing could be made out by palpation save that the liver dulness was nearly obliterated. The abdomen was very tympanitic, and no special point of tenderness or dulness was observed. He also had a double hernia. On the right side there was a protrusion of intestine beyond external ring. Pulse 140, temperature 104°. The diagnosis of a general peritonitis from a gastric or duodenal perforating ulcer was made. A large median incision was made, with umbilicus in centre for general exploration. The fingers showed nothing at rings or at cecum, and then on carrying the examination upward a minute sharply defined perforation, one-fourth inch in diameter, was found on the anterior wall of the duodenum, near pylorus, out of which was oozing some brandy and water given just before chloroformization. This was sutured with a double row of Lembert sutures and peritoneal cavity systematically and carefully washed out with sterile salt solution. Returned to ward in bad condition. Salt transfusion, 75 ounces, etc., but the patient succumbed shortly after the operation.

The autopsy showed the perforation to be in the duodenum just below the pyloric termination and in its superior anterior wall. Within the bowel was a

²⁰ Pagenstecher: Die chirurgische Behandlung des Duodenalgeschwürs. Deutsch. Zeit. f. Chir., August, 1899.

deep ulcer, at bottom of which had occurred the perforation.

LATER EFFECTS OF DUODENAL ULCER AND OPERATION FOR SAME.

There yet remain a few words to be said about the late consequences of a healed duodenal ulcer. The resulting cicatricial contraction may bring about stricture of the duodenum and dilatation of the stomach, and may by traction or primary ulceration damage the bile entrance to the intestine. Several interesting surgical cases have been reported where relief has been afforded by such circumstances. Pagenstecher quotes a case by Lange²⁷ where a gastro-enterostomy was successfully resorted to for contraction of the duodenum to the hardness and size of the finger, 3 centimetres from the pylorus, with dilatation above of the duodenum and stomach.

Codevilla (also quoted by Pagenstecher) details a more acute case with ulcer and stenosis of the duodenum and dilatation of the stomach. The duodenum was found at the operation markedly stenosed, as in Lange's case, and a gastro-enterostomy was performed, with a successful and permanently good result.

Carle²⁸ had a similar case in the front part of the duodenum, but the gastro-enterostomy resorted to ended fatally. He also reported another instance where great emaciation and stomach dilatation demanded surgical interference. The first and second parts of the duodenum were found strongly contracted but with atrophic, thin walls. Gastro-enterostomy was employed with success. Death one year later from lung tuberculosis.

Rewidzow²⁹ also cites a case which is doubtfully placed among these, as the locality of the stenosis following bloody vomiting and gastric disorder for twenty years was shown at the operation to be below the bile papilla, where a stenosis existed. For this a gastro-enterostomy was successfully resorted to.

OPERATIONS FOR DUODENAL PERFORATIONS.

The following list embraces all the reported cases of perforation of the duodenum that have undergone operation up to April, 1900, and have been carefully investigated and epitomized by Dr. E. M. Foote, to whom I am much indebted for this and other help in the preparation of this article:

CASE I. Male, age thirty-five. A heavy drinker; no history of indigestion. For a week or so loss of appetite and indefinite epigastric pain; then sudden acute pain while at work, followed by vomiting. Two days later brought to hospital in collapse. Abdomen distended, dullness in right flank; pulse rapid and feeble; temperature 98.8° F. Laparotomy at end of two days. Acute peritonitis; cause not discovered. Death in a few hours. Autopsy: Perforation anterior wall of duodenum close to pylorus.³⁰

CASE II. Male, age thirty-one. Acute attack like intestinal obstruction. Diagnosis: Appendicitis and general peritonitis. Operation, third day. Appendix normal; general peritonitis; perforation not found. Death in a few hours.³¹

CASE III. Male, age twenty-nine. History of abdominal colic. While in usual good health was seized at 5 p. m. with sudden pain, followed by bilious vomiting. Some lumps of feces and gas passed that evening, but absolute

constipation thereafter. Next day a purgative only increased the vomiting and pain. Entered hospital on third day, with fecaloid vomiting. On fourth day great distention, tenderness and pain at its maximum in right hypochondrium. Pulse 120, small; dullness in both flanks. Diagnosis: Perforative peritonitis. Operation in about ninety hours. General peritonitis. The hand thrust under the liver broke into a cavity containing two quarts of serous liquid. The intestine was searched in vain for mechanical obstruction, and on account of weakness of patient, the operation was terminated. Death same evening. Autopsy showed a perforation "near the end of the second portion of the duodenum, externally."³²

CASE IV. Male, age twenty-eight, always well. While drinking tea, had a violent pain in the left side of the abdomen. Next day, a tumor to the right of umbilicus; sour vomit, later becoming fecal; tympanites; constipation, no blood; third day, temperature normal, pulse about 130. Operation in eighty hours (about). Incision to left of umbilicus gave vent to gas and pus; intestine sound; greatly distended; incision of intestine; suture of collapse; drainage. Death in seven hours. Autopsy: Perforation in anterior wall of duodenum; purulent peritonitis.³³

CASE V. Male, age forty-one, of good previous health except slight indigestion. One year before perforation, an attack of abdominal pain with constipation. While at work was seized with violent pain; gastric vomiting, later becoming fecal; no blood; absolute constipation. In tympanitic stage, when first seen by reporter; respiration thoracic; pulse 120, temperature 99.2°. Diagnosis: Septic peritonitis. Operation, May, 1891. Usual incision; cavity searched; no cause for suppurative peritonitis found; irrigated; drained. Death in ten hours. Autopsy: Perforation in posterior wall of duodenum, 1 inch below pylorus, freely communicating into peritoneal cavity when intestines were lifted.³⁴

CASE VI. Female, age twenty, servant. Of constipated habit; otherwise health good. Bowels moved by salts two days before the attack. A sudden attack of pain in the right hypochondrium, passing then to left side, and afterwards becoming general. Vomiting of sour fluid began twelve hours after the attack of pain, and continued. There was tympanites without loss of hepatic dullness. Diagnosis of general peritonitis, cause unknown. Operation in twenty-four hours. A median incision below the umbilicus allowed the escape of inoffensive fluid. A second incision above the umbilicus disclosed the perforation, one-quarter of an inch in diameter, in the posterior aspect of the duodenum, close to the pylorus. Milk was escaping through it. The ulcer was excised and sutured, the abdomen flushed. Death in six hours. General peritonitis.³⁵

CASE VII. Male, age twenty-one. Always good health. Sudden pain in the lower abdomen, followed by vomiting and collapse. After eighteen hours laparotomy gave exit to much brownish, acid, non-feculent fluid. There was adhesive peritonitis. The cause of peritonitis was not found. Death in a few hours. Autopsy: A perforation in the anterior wall of the duodenum, about 5 inches from the pylorus, and about 5 inches in diameter; a second non-perforating ulcer of the posterior duodenal wall.³⁶

CASE VIII. Male, age fifty-six, brought to the hospital in a condition of tympanites, and having a right inguinal hernia. Laparotomy. The hernia was explored and found to be in good condition, and the incision was prolonged upward 7 inches, giving vent to purulent and fecal fluid. No cause for the peritonitis was found about the cecum or elsewhere. Death in a few hours. On the anterior surface of the duodenum, .5 inch from the pylorus, was a perforated ulcer, .5 x .7 inch. It could easily have been sutured.³⁷

CASE IX. Male, age twenty-eight. Of good health until two months before perforation, did not feel quite himself, but no localized symptoms. While ascending an

²⁷ Pagenstecher: Die chirurgische Behandlung des Duodenalgeschwürs. Deutsch. Zeit. f. Chir., August, 1899.

²⁸ Loc. cit.

²⁹ Loc. cit.

³⁰ Mackenzie (Jones, operator): Lancet, 1888, II, p. 1,060.

³¹ Mackenzie (Croft, operator): Loc. cit.

³² Boiffin: Cong. fr. de chir., 1892, p. 210.

³³ Lockwood: Medical Society Transactions, 1892, vol. xv, p. 91.

³⁴ Loc. cit.

³⁵ Gould: Middlesex Hospital Reports, 1893, p. 108.

³⁶ Perry and Shaw: Guy's Hospital Reports, 1893, vol. I, p. 261.

³⁷ Lockwood: Lancet, 1894, II, p. 964.

omnibus, felt a sudden pain in the abdomen; nausea and vomiting after an emetic had been given; constipation for four days, then a little fecal matter and flatus after an enema. Seventh day, entered hospital; abdomen distended; general tenderness; respiration 28, thoracic; pulse 104, temperature 99.8°. Questioned with reference to duodenal ulcer, could not localize first pain; never any blood by mouth or in stools; only slight indigestion. No evidence of trouble in upper part of abdomen. Diagnosis: Septic peritonitis with pus in pelvis. Operation in one hundred and fifty hours (about). Subumbilical incision; two pints of pus from pelvis; appendix, cecum and small intestine sound; higher search abandoned, as there was less peritonitis in that direction; irrigation, drainage, suture. Death in fifty-four hours. Autopsy: Septic peritonitis in pelvis, and also about duodenum, these areas being separated by a middle zone, relatively free from peritonitis; perforation, .5 inch in diameter, .7 inch from the pylorus, in the upper wall of the duodenum.³⁸

CASE X. Male, age sixty-one, with a long history of gastric ulcer, with epigastric pain and vomiting, never of blood. Sudden pain in right hypochondrium; collapse. Diagnosis: Perforation of gastric ulcer. Operation in four hours, fifteen minutes. Perforation in duodenum, anterior wall, .7 inch from pylorus, sutured; thorough washing, drainage. Death in six days. Autopsy: Suture tight: a second ulcer in the back of the duodenum, non-perforating; purulent fluid behind liver and in pelvis.³⁹

CASE XI. Male, age twenty-eight. Good health. One hour after a movement of the bowels, while lifting barrel from a dray, felt a sudden pain across the abdomen like a knife; vomiting immediately began and continued. Third day fecal vomiting; pain especially on right side. Pulse rapid, temperature 100.6°, respiration rapid, cold sweat. Diagnosis: Intestinal obstruction. Operation in sixty-two hours. Subumbilical incision gave vent to a large amount of seropus with a fecal odor; cecum, appendix, hernial openings, and intestine in pelvis examined; incision prolonged upward; perforation as "big as a florin," in anterior wall of duodenum, 1 inch from pylorus, pared and closed with six or eight Lembert stitches. Area covered by omentum; irrigation; drainage in pelvis. Death in three hours. No autopsy.⁴⁰

CASE XII. Female, age twenty-seven. For a fortnight had epigastric pain, and constipation for seven or eight days; treated for indigestion. Sudden pain in epigastrium and collapse; vomiting frequently repeated. Thirty hours later slight tympanites, and abdomen uniformly tender; pain most marked in epigastrium; vomiting; respiration rapid and irregular, pulse 120, temperature 100.6°. Diagnosis: General peritonitis from mechanical obstruction. Operation in thirty hours (about). Subumbilical incision gave vent to fluid and fibrin; intestinal cells congested; no lesion found; incision prolonged upward; gas noticed near gall-bladder; perforation of duodenum .7 inch from pylorus; surrounding induration incised; suture; irrigation; sponging; no drainage. Nothing by mouth for seventeen days; recovery. Two months later symptoms of obstruction; operation on third day; adhesions, which obstructed the ileum a short distance above the cecum, freed. Death from perforation of the wall of the ileum just above the obstruction. The suture of the duodenum was smooth and thin.⁴¹

CASE XIII. Male, age thirty-five, of alcoholic habit. Upon going to work was attacked by sudden abdominal pain and vomiting; pain and nausea continued, though vomiting ceased. Thirty hours later the patient lay with hollow eyes, alternately extending and drawing up his legs as paroxysms of pain came on. Nothing had passed by anus. There was tympanites except for dulness in right iliac region, where pressure was painful. No tumor could be made out. Temperature 37.9° C. (100° F.) pulse 104 and small. Operation by Brissaud, fifty-one hours after the attack, December 14, 1893. An incision was made over

the appendix, giving vent to a great quantity of fecal matter. The appendix was not seen; drainage. Death in a few hours. Autopsy: General peritonitis, and a fusiform collection of pus from the liver to the right iliac region. There was perforation of an ulcer in the anterior wall of the duodenum, just below the pylorus.⁴²

CASE XIV. Male. After a debauch the patient was attacked with a sharp pain in the right side of the abdomen. Forty-eight hours later there was general tympanites, fulness over a tumor in the right iliac region and collapse. Operation in fifty-three hours as for appendicitis. From the incision pus and milky fluid escaped in large amounts. Irrigation and drainage. Death. Autopsy showed a perforated duodenal ulcer, the sac about the cecum containing much of the milk and food which had been taken during illness.⁴³

CASE XV. Male, age twenty. Slight indigestion. While at the theatre a sudden attack of severe pain in the epigastrium with tenderness; no vomiting; passage of flatus; slight tympanites. Temperature 96°, pulse 100. On the second day greenish vomiting, becoming fecaloid; obstipation; rapidly increasing tympanites; tenderness in the cecal region. Diagnosis of appendicitis. Operation in about sixty hours. Gas without odor, thin, purulent fluid, and lymph in peritoneal cavity. Perforation not found; intestines washed; abdomen closed. Death in twenty-four hours. Perforation anterior aspect of first portion of duodenum.⁴⁴

CASE XVI. Male, age twenty-three. An attack of sudden pain, vomiting and obstipation three years previously. An acute attack of pain and vomiting lasting five days. There were two movements of the bowels in this period. When seen on the sixth day, there was marked tympanites and a very rapid pulse, not much tenderness, and pain in the cecal region. Diagnosis of appendicitis. An incision about one hundred and five hours after attack allowed odorless gas and thin pus to escape. The intestinal coils were covered with lymph, and greatly distended. An incision into the jejunum permitted several pints of fluid to escape. Perforation not found. Abdomen washed and drained. Death in twenty-two hours. Autopsy: There was a small perforation of the anterior wall of the duodenum, one-half inch below the pylorus. At the same distance, there was in the posterior wall the scar of a healed ulcer.⁴⁵

CASE XVII. Male, age twenty-eight, hard drinker. Sudden abdominal pain accompanied by vomiting. Two days later admitted to hospital with general abdominal distention and tenderness, but no loss of liver dulness. Temperature 103°, respiration 20, pulse 120. On third day a liberal median incision revealed a general peritonitis, with a small amount of fluid; cause not found. Rapid irrigation and drainage. Death three days after operation. Autopsy showed a sharply defined ulcer in the third part of the duodenum, in its posterior wall. The ulcer had for its base the pancreas, whose tissues were necrotic and infiltrated with pus. The suppuration had extended as far as the jejunum, and had there entered the general peritoneal cavity.⁴⁶

CASE XVIII. Male, age thirty-five, a hard drinker, with a history of a similar attack thirteen years previously. For a few days there was a severe abdominal pain accompanied by vomiting. Was admitted to the hospital with very great general tenderness, no distention, and a temperature of 102°. The symptoms improved until the fourth day after admission, and then signs of a rapidly spreading peritonitis were manifest. Diagnosis of appendicitis. Incision made on the fourth day over the appendix showed that organ to be normal. There was a general peritonitis and a large quantity of odorless fluid in the abdomen. Drainage. Death in a few hours. Autopsy showed a perforation in the superior wall of the first portion of the duodenum just beyond the pylorus. The gut

³⁸ Lookwood: *Lancet*, 1894, II, p. 968.

³⁹ *Loc. cit.*

⁴⁰ *Ibid.*: *Lancet*, 1894, II, p. 1891.

⁴¹ Dean: *Medical Society Transactions*, 1894, vol. xvii, p. 305.

⁴² Collin: *Thèse de Paris*, L'Ulère simple du duodenum.

⁴³ Bryant: *Medical Record*, 1895, vol. xlviii, p. 25.

⁴⁴ Shield: *Lancet*, 1895, I, p. 1170.

⁴⁵ *Loc. cit.*

⁴⁶ Bolton: *Medical Record*, 1900, vol. lvii, p. 494.

was adherent to the liver by recent fibrin. There was also the scar of an old healed ulcer.⁴⁷

CASE XIX. Male, age fifty-six. Long history of gastritis and diarrhea and sometimes of blood. Acute attack of pain, four hours after dinner; constant vomiting; collapse. The usual lavage failed to give relief and the water did not return readily. Morphine administered; passage of gas per anum. The next day symptoms disappeared then returned with vigor. Stool after enema. The second day there was again a remission and again a relapse toward night. Dulness and pain most marked in the right iliac fossa. Pulse 112, temperature 38.2°. The third day still iliac tumefaction; marked sepsis; pulse 160. Operation sixty-six hours after attack. Incision over appendix, which was thought to be the origin of the disease, allowed the escape of three pints of reddish virulent fluid with fibrin masses. The peritonitis appeared limited, and it was decided best not to break up the adhesions to find the perforation. Douche and drainage. Death nine hours after operation. Autopsy: An ulcer just below the pylorus occupied two-thirds of the circumference of the duodenum, the anterior wall being not involved. The perforation was on the postero-external surface.⁴⁸

CASE XX. Male, thirty-three. No previous gastric trouble. Sudden colicky pain in right hypochondrium; collapse; no defecation nor passage of wind. Following day, tympanites; liver dullness absent; temperature 100° F., pulse 122, respiration 38. Operation in twenty-five hours. Incision median line; purulofibrinous peritonitis; gas and fluid from duodenal region; perforation sutured by two rows of stitches; intestines cleaned by moist gauze; no drainage. Recovery after bronchitis; primary union of wound. Patient seen four years later, in good health.⁴⁹

CASE XXI. Male, thirty-five, a hard drinker. Sudden severe abdominal pain, without vomiting. Admitted to the hospital eight hours later with a tense abdominal wall and tenderness over the gall-bladder. The pulse was 90, and there was no fever. Later the temperature rose, distention with obliteration of the liver dullness developed. Diagnosis of appendicitis. Operation in twenty hours. Incision over appendix, which was normal. A well-marked general peritonitis was present, but the patient's condition prevented further search. Death in twenty-four hours. Autopsy showed a perforation of the duodenum in the posterior wall one and one-fourth inches from the pylorus, and a second non-perforating ulcer lower down.⁵⁰

CASE XXII. Male, age fifty-two. Attack of acute pain in epigastrium with obstipation and tympanites six years previously. Recovery in six weeks. More or less pain since. Acute attack of severe pain about pylorus, later extending downward and backward. Absolute obstipation; tympanites slight on second day and increasing; vomiting on third day of moderate character; temperature 100° to 100.5°. Diagnosis of appendicitis. Operation on fourth day. Intestines distended and covered with lymph; no pus. Perforation of duodenum into general peritoneal cavity found and closed. Cavity douched with hot water; gauze drain. Thirst and brownish vomiting; rapidly rising temperature. Death on third day after operation. No autopsy.⁵¹

CASE XXIII. Male. Sudden epigastric pain while at work, followed by vomiting, tympanites, and loss of liver dullness. Operation in about thirty hours. Perforation in anterior wall of first portion found and sutured. Gas and yellowish fluid in peritoneal cavity. Flushing with hot water; drainage for twenty-four hours. During convalescence return of symptoms necessitated a second laparotomy. Only adhesions of liver to diaphragm. A needle thrust through eighth intercostal space into these drew a

drop of pus. A mural abscess formed later which probably caused the above recurrence of symptoms. Recovery.⁵²

CASE XXIV. Male, age fifty, who for ten or fifteen years had pain after meals, with vomiting and bloody stools. Last hemorrhage seven months before entrance to hospital. Emaciated and anemic on entrance; stools black; diagnosis of ulcer ventriculi. Two days later sudden pain in right hypochondrium, with retracted abdomen. Temperature 100°, pulse rate normal. The signs of peritonitis with feelings of distention increasing, laparotomy was performed twelve hours after the attack. A long incision made above umbilicus with cross cut to the left and right; stomach and duodenum examined and fluid like coffee grounds squeezed from its posterior region by pressure, but no perforation could be made out. Duodenum, stomach and colon were sutured together to protect the general peritoneal cavity. Cavity irrigated and wiped and drained at epigastrium and through pelvis. Recovery. Six months later in good condition, as far as duodenal ulcer went. Still had chronic gastritis. Death in eight months from operation for suppurative peritonitis. Autopsy: A new perforation in the posterior wall at the beginning of the second portion of the duodenum.⁵³

CASE XXV. Male, age twenty-four years, with no gastric trouble. After a large dinner he felt indisposed for a few minutes. The next morning he rose at six in usual good health and ate his customary breakfast. At the last mouthful of a glass of white wine, he felt a sudden most severe pain and lay down in bed. There was vomiting of food, and afterward incessant vomiting of bile. He described the pain as "not like a general colic, but always in one point here," indicating a spot on the left, midway between the umbilicus and ensiform. A physician diagnosed volvulus, and tried by enemata and massage to relieve pain. In five hours vomiting ceased and the pain subsided somewhat and was referred to the lower abdomen. No fecal matter nor gas passed the anus. There was no tympanites nor difficulty in passing water. Sixteen hours after the attack he was admitted to the hospital. The abdomen was retracted and board-like, the pain was less and vomiting had ceased. There was costal respiration, and appearance of the face indicated severe abdominal trouble, the nose pinched, the eyes sunken, the hands clammy and the patient in a half stupor. Diagnosis was thought to lie between appendicitis and duodenal perforation. Nineteen hours after the attack an incision was made in the median line from the pubis to above the umbilicus. The abdomen contained non-feculent fluid, and there were light adhesions on the intestinal coils. Appendix normal; no intestinal lesion; pelvis normal. Incision prolonged upward and stomach searched; gas found escaping from under liver, and perforation near pylorus on anterior surface of duodenum sutured. Abdomen wiped and drained from site of duodenum. Several saline injections, amounting to 4,200 cubic centimetres in all. Death in twenty hours from peritonitis; suture tight.⁵⁴

CASE XXVI. Male, age twenty-six. Health perfect, never any gastric symptoms. Two hours after his usual light breakfast, while making a slight effort to open a sack, the patient experienced an intense pain in the left side of his abdomen. He was taken almost at once to a hospital. Diagnosis of appendicitis; treatment by ice and opium. Following day a feeble pulse, without fever; abdomen distending; tenderness in left iliac fossa. On second day vomiting set in, becoming bloody and bilious. About fifty-six hours after the attack, Sebileau made an incision as for appendicitis, permitting the escape of non-feculent fluid, like bouillon. The appendix was normal. The patient was already collapsed, and nothing further was done, except to drain with gauze and give a saline injection. Death after incessant vomiting in thirty hours. Autopsy: Abdomen contained fluid. There was general peritonitis; per-

⁴⁷ Bolton: Medical Record, 1900, vol. lvii, p. 494.

⁴⁸ Festal: Jour. de Méd. de Bordeaux, 1885, vol. xxv, p. 49.

⁴⁹ Herzel, 1895, quoted by Pagenstecher: Deut. Zeit. f. Chir., 1899, vol. lili, p. 557.

⁵⁰ Bolton: Medical Record, 1900, vol. lvii, p. 494; also in previous article on perforating ulcer by Weir and Foote, Medical News, 1896.

⁵¹ Warren: Boston Medical and Surgical Journal, 1896, vol. cxxiv, p. 460.

⁵² Dunn: British Medical Journal, 1896, i, p. 846.

⁵³ Landerer and Glucksman: Mitt. Grenzgebiet. Med. und Chir., 1896, vol. i, pp. 168 and 738.

⁵⁴ Jannet and Lardennols: Bull. Soc. Anat., Paris, 1897, vol. lxxii, p. 479.

foration in the anterior wall of the duodenum 1 centimetre from the pylorus.⁵⁵

CASE XXVII. Male. Attack of sudden pain like lead colic. Incision from the ensiform downward. There was food under the liver, and a perforation was found in the first part of the duodenum. Suture. Death in twelve hours.⁵⁶

CASE XXVIII. Male, policeman, of alcoholic habit and history of gastric attack. While on duty the patient had a sudden attack of pain which made him writhe in agony. His bowels had moved a short time before. When seen soon after the abdomen was retracted, as hard as a board, excessively tender, especially under the ribs and in the right flank. Diagnosis of hepatic colic. Compresses were applied and morphine administered. The following day he felt better. An injection resulted in a large stool. Milk and vichy were administered. There was no fever and not much pain, but the abdomen was still retracted. Thirty hours after the attack vomiting set in, soon becoming bilious. The abdomen swelled and the patient was taken to a hospital. Diagnosis: Appendicitis, intestinal obstruction or volvulus. Abdomen opened forty-eight hours after the attack. Nothing but general peritonitis discovered. Dieulafoy, operator. Death in one hour. Autopsy showed a perforation of the duodenum in the anterior wall just below the pylorus.⁵⁷

CASE XXIX. Female, age twenty-five, servant, giving a history of gastric trouble with vomiting, but never of blood. An increase of gastric pain, with general tenderness and abdominal swelling, was followed four days later by marked distention. Palpation showed the greatest tenderness to be in the cecal region. There was no fever. A needle thrust into the right iliac fossa brought out gas and an odorless fluid, containing flakes of fibrin. An incision was made over the appendix, which was congested. There was general peritonitis. Death in four days from the operation. Autopsy showed pus in the pelvis and about duodenum, in the lower wall of which, close to the pylorus, there was a perforated ulcer. A second ulcer was situated in the posterior wall.⁵⁸

CASE XXX. Female, thirty-four, servant, with a history of gastric troubles for twenty years, with frequent vomiting of blood; last attack one week before admission to the hospital, the vomiting being followed by bloody stools. Pulse 84, regular, strong; rectal temperature 98.6°. Maximum pain midway between ensiform and umbilicus to the right of the median line. Ice bag on abdomen, nothing but ice by mouth. Next day pain involved the whole right side; was relieved by morphine, but recurred with vomiting, a small pulse of 106, and cold sweat. More morphine was given. Two hours later the pulse was 130, there was tenderness all over the abdomen, and edema in the epigastrium. Diagnosis: Gastric ulcer. Laparotomy two days after admission to the hospital, thought by the operator to be "at least fifteen hours after perforation" through the left rectus above the umbilicus; gas and fluid escaped; no adhesions; general peritonitis. Perforation at pylorus, thought to be in the lesser curvature, sutured. Abundant irrigation; gauze drainage; 700 cubic centimetres saline injected. Death twenty-four hours after operation. Autopsy: Perforation in the superior wall of the duodenum near the pylorus. The suture was perfect.⁵⁹

CASE XXXI. Female, age fifty-four years, with history of indigestion, no bloody vomiting. A sudden attack of pain and vomiting, not of blood, followed by a large bloody stool and several small ones of a tarry character. Was followed eighteen days later by a second attack. There was tenderness and resistance to the right of the median line above the umbilicus; no fever. Laxatives and enemata relieved the abdomen of gas and fecal matter and the area of resistance became a well-defined tumor. Nine days after the last attack an incision was made through the

right rectus muscle, and in separating the abdominal wall from the viscera several small abscesses were opened, and through one of these gas and gastric contents escaped. Perforation readily found and closed. It was at the pylorus and thought to be in the stomach. The gall-bladder was opened and eight stones removed. Most of the omentum excised. Iodoform gauze drains were inserted. Death in five weeks. Autopsy showed that the abdominal condition was perfect. Death was due to pulmonary thrombosis infarction, from saphenous thrombosis. The sutured ulcer had healed. Two others in the duodenum had not perforated.⁶⁰

CASE XXXII. Male, age thirty-seven, shoemaker, with nausea and vomiting and indigestion, more or less for years. One morning he awoke feeling perfectly well. On sitting up in bed he was seized by a terrible pain in the umbilicus and to the right side lasting several hours, and followed by vomiting. Enemata resulted in several small stools. The next day he was taken twenty-five miles in a sleigh to the hospital, where he arrived with respiration 26°, pulse 140, temperature 102.5°, but free from pain while at rest; tenderness in left iliac fossa, and in the right hypochondrium, and over right rectus muscle. Stomach and bowels washed out. Diagnosis of duodenal ulcer or appendicitis. Sixty hours after the attack an incision was made in the median line, mostly below the umbilicus. Fluid and gas and fibrin escaping mostly from above, the cut was extended upward and the right rectus was cut across. A perforation into which the index finger passed was found in the anterior superior wall of the duodenum near the pylorus. It was sutured and the cavity washed out with water at a temperature of about 45° C., wiped out and drained in both loins as well as about duodenum and liver. Compresses wrung out of hot saline were placed in the wound which was left open. The pulse and temperature gradually rose, and in spite of 1,150 cubic centimetres of salt solution injected into a vein, the patient died in twenty-six hours after operation. Autopsy: Fibrous peritonitis without fluid. The suture was firm. There was an abscess between the stomach and colon.⁶¹

CASE XXXIII. Male, age forty-six. While lifting a heavy weight, he felt something snap, and immediately afterward there was intense pain (locality not given), which soon spread to the whole abdomen. Four days later he entered the hospital, not having passed gas or fecal matter per anum. There was no localized pain, but pressure was everywhere painful; no tumor nor fluctuation. The patient had not vomited, but had a hiccup; pulse irregular, 110; temperature 99°. A diagnosis of intestinal obstruction was made and castor oil was given in small doses every hour. The next day there was great prostration and choreic movements. Five days after the attack the abdomen was opened by a median incision from pubis to ensiform, with a cross cut through the right rectus muscle. There was general peritonitis with pus and membranes all over, but especially in the pelvis. At the pylorus on the superior surface was a large perforation, which was sewed with difficulty, and the abdomen flushed and closed. Death two hours after the operation.⁶²

CASE XXXIV. Female, age thirty, with a history of indigestion and some epigastric pains. While eating breakfast she was seized with a terrible pain in the epigastrium and left the restaurant for a seat in the park close by. She was taken at once to a hospital. In six hours the pain was general and vomiting set in. The following morning she was worse, without stools or passage of gas, and scanty urine. The condition grew rapidly worse, with rapid pulse, subnormal temperature, tympanites and loss of liver dullness. A diagnosis of perforation, probably of the stomach, was followed by operation, twenty-eight hours after the attack. Incision above the umbilicus gave escape to gas and a quart of bile and purulent fluid. Stomach and biliary tract normal, and perforation found in the right side of the second portion of the duodenum. Open-

⁵⁵ Lardonnois: Bull. Soc. Anat., Paris, 1897, vol. lxxii, p. 46.

⁵⁶ Solignoux: Bull. Soc. Anat., Paris, 1897, vol. lxxii, p. 72.

⁵⁷ Bousse: Jour. de Méd. de Paris, 1897, vol. ix, p. 146.

⁵⁸ Lendonner: Mitt. Grenzgeb. Med. und Chir., 1898, vol. iv.

⁵⁹ Loc. cit.

⁶⁰ Lendonner: Mitt. Grenzgeb. Med. und Chir., 1898, vol. iv.

⁶¹ Loc. cit.

⁶² Schwarz (Rochard, operator): Bull. et Mem. de la Soc. de Chir., 1898, p. 3.

ing sutured and abdomen closed over a rubber drain to duodenum. Death in fourteen hours. Autopsy: Perforation a little below and to the right of the opening of the common duct explained why the bile flowed so freely into the abdomen. The closure was perfect. There was a second ulcer a little below the first which had not perforated.⁶³

CASE XXXV. Male, age twenty-three, a soldier, with a history of numerous sprees before he entered the army. During a march he took a cup of coffee, and almost immediately he was overcome by pain in the epigastrium and right hypochondrium, streaming into the right shoulder. He was nauseated but did not vomit. There was tenderness and muscular contraction on pressure, especially on the right side. An enema produced a normal defecation. The pain spread over the whole upper part of the abdomen, accompanied with a certain amount of distention, constant vomiting of greenish fluid and a partial disappearance of the liver dullness. Incision above the umbilicus forty-eight hours after the attack. General peritonitis. Intestine overhauled, then liver examined. Bubbling at its base led to the discovery of the duodenal perforation in the posterosuperior wall of the first portion of the duodenum. The right rectus was divided to give room for suturing, but the stitches would not hold, and the perforation, of a size to admit the little finger, was walled off from the peritoneal cavity by omentum sutured above and below it. Death in thirty-six hours of general peritonitis. There were no other lesions found at autopsy.⁶⁴

CASE XXXVI. Male, age twenty-two. Always perfectly healthy. An acute attack of intense pain and vomiting three hours after supper; pain referred to the umbilicus and right side. On the following morning, temperature was 101°, pulse 120, respiration 42; moderate tympanites; lower edge of liver dullness 2 inches above the costal margin; tenderness most marked in the epigastrium and on the right side of abdomen. Diagnosis of peritonitis, probably due to appendicitis. Operation fifteen hours after the onset of attack. Incision over appendix. General seropurulent peritonitis. Appendix appeared normal but was excised. A second incision above umbilicus revealed after careful search a one-fourth-inch opening in the anterior wall of the first portion of the duodenum, close to the hepatic ligament. It was in the centre of an indurated area, and on account of its deep situation, no excision was made. Suture, and cleansing of the peritoneum with gauze. Closure of abdomen over iodoform gauze drain. Recovery with severe illness.⁶⁵

CASE XXXVII. Male, age thirty-eight, with history of attacks of intense pain in the epigastrium three or four hours after meals, without nausea or vomiting. While in usual good health, suffered an acute attack of violent pain in epigastrium with collapse. He recovered somewhat and then grew gradually worse, with vomiting on the third day; no movement of the bowels for a week before the attack. On the third day temperature 100°, pulse 99, respiration 30; face drawn; abdomen distended with gas; dull in flanks; liver dullness absent. Operation about seventy-two hours after onset of acute symptoms. Through an incision in the median line, much gas and thin greenish-yellow purulent fluid escaped, with flakes of lymph; appendix normal. A search over the intestine showed the perforation to be in the anterior wall of the duodenum near the pylorus. It was sutured and the abdomen swabbed out. The operation lasted two and one-half hours. Afterwards one quart of saline solution was injected into the basilic vein. Death in eight hours. The peritoneal cavity was dry, except six ounces of pus between the diaphragm and liver. The suture was tight and adhesions had already formed around it.⁶⁶

CASE XXXVIII. Male, age thirty, with a history of dyspepsia. While stooping to draw off his boots, the patient suffered a severe pain in his stomach which stretched

him out. The following day an enema was without result. The abdomen was swollen and painful, the pain being all about the umbilicus, the urine scanty and the pulse 120. About twenty-seven hours after the accident an incision was made in the median line at the umbilicus. The intestinal coils were distended and red. A mass of fecal matter seemed to clog the lumen, and was pushed along for a couple of yards. There was a suspicious yellow fluid in the peritoneal cavity, and pus in the pelvis. The appendix was normal. The abdomen was flushed with boric-acid solution and closed. The vomiting ceased, gas and a great quantity of feces passed and the abdomen became soft. Five days later the patient was attacked with dyspnea and double pneumonia developed. Death in nine days after the operation. There were numerous pus foci in the abdomen, and a perforation of the duodenum partly shut in by adhesions.⁶⁷

CASE XXXIX. Female, age seventeen, and fairly healthy; had rarely suffered from indigestion. One week before perforation occurred there had been indefinite pain in the abdomen for which she consulted a physician, who feared a beginning attack of appendicitis. About three hours after eating a hearty supper, she was seized with a violent pain above the umbilicus. Prostration followed, with rapid pulse, subnormal temperature, vomiting and rigid abdominal muscles. Infusion of saline solution and stimulants failing to improve the patient's condition, operation was performed twelve hours after the beginning of the attack. Incision as for appendicitis; appendix and pelvic organs normal, as was the small intestine. In the upper part of the abdomen there was a good deal of lymph and greenish fluid. The perforation of the duodenum was in the anterior wall of its third portion and was about the size of a goose quill, and surrounded for about an inch an indurated area. Fluid was freely escaping. Direct sutures would not hold, so a purse string was inserted, and afterward other peritoneal sutures. In this way the opening was firmly closed. Lymph and fluid were wiped away and the abdomen flushed with a great quantity of hot saline solution. Numerous gauze drains were inserted. Convalescence was slow, as it was a long time before the suppurating tracts, where the drains had lain for a week, had healed, but the patient ultimately recovered completely.⁶⁸

CASE XL. Male, age thirty. Sudden pain in abdomen, followed by shock and toxic symptoms. Operation thirty-six hours later as for appendicitis. Perforation found in first portion of duodenum. No blood nor food in peritoneal cavity. Death in a few hours.⁶⁹

CASE XLI. Male, age forty. Seized with pain while at work, followed by shock and toxic symptoms and great tympanites. Operation in twenty hours. Perforation found in first portion of duodenum, no blood nor food having escaped. Death in a few hours.⁷⁰

CASE XLII. Male, age thirty-eight. Supposed pulmonary abscess was opened and a large quantity of pus escaped. Two weeks later an abscess formed in groin and was opened. Later the abdomen was opened for appendicitis and a quart of creamy pus containing streptococci escaped. Death followed. Autopsy showed two ulcers near pyloric ring, one in the duodenum, the base of which had healed over, and one in the stomach—perforated. There were numerous pus pockets in the abdomen, one in the head of the pancreas being the original one apparently.⁷¹

CASE XLIII. Male, age twenty-nine. Alcoholic. Three years morning vomiting. Following a long spree he felt umbilical pain and vomited and had a chill. The next day the abdomen was moderately distended and rigid. Diagnosis of general peritonitis from appendicitis. Operation one to two days after attack. About one quart of fluid and fibrin escaped. Appendix amputated. Death in thirty hours. Autopsy revealed perforation in superior anterior surface of duodenum near pylorus.⁷²

⁶³ Schwartz (Gulnard, operator): *Bull. et Mem. de la Soc. de Chir.*, 1898, p. 3.

⁶⁴ Schwartz (Stein, operator): *Loc. cit.*

⁶⁵ Wanach: *Arch. f. klin. Chir.*, 1894, vol. lvi, p. 425.

⁶⁶ Whipple: *British Medical Journal*, 1898, vol. II, p. 1429.

⁶⁷ Routier: *Bull. et Mem. de la Soc. de Chir.*, 1899, p. 17.

⁶⁸ Taylor: *North Carolina Medical Journal*, 1899, vol. xliii, p. 109.

⁶⁹ Erdmann: *Medical Record*, 1899, vol. lv, p. 477.

⁷⁰ *Loc. cit.*

⁷¹ Brooks: *Medical Record*, 1899, vol. lvi, p. 943.

⁷² Brooks (Le Boutillier, operator): *Loc. cit.*, p. 944.

CASE XLIV. Male, age thirty. History of gastric disturbance; no hematemesis. Sudden severe epigastric pain, with chill, fever and repeated vomiting and great prostration. No blood by mouth or rectum. Gradually increasing distention and tenderness. Four days later, April 30, 1900, he entered the New York Hospital, the abdomen generally swelled, but not presenting any special points of tenderness or dullness. Liver dullness absent. Patient had a double hernia, and in the right hernial sac intestine was to be felt. Temperature 104°, pulse 140. Median incision with umbilicus in centre. Nothing abnormal found at the internal rings or about the cecum. From a one-fourth-inch perforation in the anterosuperior wall of the duodenum close to the pylorus, brandy and water was found escaping. Closed with a double row of sutures; thorough washing of intestines and cavity; saline transfusion of 75 ounces, etc. Death in a few hours. Operator, Weir. Case not previously reported.

CASE XLV. Male, age twenty-seven, always healthy, but a steady drinker. Had colicky pain for four days, above umbilicus on the right side. Bowels moved daily and he kept on working. Then sudden severe pain 3 inches above the navel, and a little to right of median line; chill; no nausea. Nine hours later pulse 80, respiration 20, temperature 101.5°. March 28, 1899, abdomen opened ten hours after sudden pain, along right semilunar line above and below umbilicus; bile-stained fluid escaped; appendix examined as a matter of precaution and found normal. Incision extended upward to ribs. Perforation of duodenum, anterior surface, descending portion, big enough to admit 26 French sound, through which bile and intestinal contents were escaping. All organs in vicinity showed signs of irritation and so were washed with saline while opening was closed by pad. Suture of perforation; repeated flushing of peritoneal cavity without evisceration and wiping with dry gauze; gauze drain to ulcer; wound elsewhere closed. No shock. Patient fed by rectum for forty-eight hours. Temperature following day 101° F., and infection of skin stitches, which were removed. Recovery otherwise uneventful and perfect.⁷³

CASE XLVI. Female, age twenty-five. Sudden attack of umbilical pain, rigor and slight vomiting. On following day pain at pylorus and blood passed per rectum. Temperature then and later 101° F. or less. Attack gradually subsided, but in two weeks a similar slighter attack occurred. Later a fluctuating tumor in region of gall-bladder, gradually increasing in size until it occupied the whole right upper quadrant of abdomen. It was crossed by resonant colon; elsewhere dull on percussion. Diagnosis: Hydronephrosis. Through lumbar incision a quart or more of clear amber odorless fluid drawn off. Cyst reached from liver to iliac crest, and backward to spine. Kidney not felt. Stuffed with gauze, which next day was soaked with sour fluid. On third day food noticed in dressing. Patient developed acute bronchitis and died on fifth day. Autopsy showed duodenal perforation 3.5 inches from pylorus forming this retroperitoneal cyst below right kidney and reaching behind duodenum as far as pancreas.⁷⁴

CASE XLVII. No history given. Incision from ensiform cartilage to pubis. Ulcer found at back of the duodenum and with difficulty stitched. Patient collapsed and abdominal wound hastily closed. Death from hemorrhage from a vessel in the abdominal wound.⁷⁵

CASE XLVIII. Male. Patient neurasthenic and little attention was paid to his statement that he had great pain. Operation on the fifth day, when liver dullness was entirely obscured. Gas had escaped from the perforation, but no fecal matter, and the ulcer was therefore sutured and the abdominal wound closed without drainage. Death on the third day from infection leading from the site of perforation to the pelvis. Suture firm. The operator thought that pelvic drainage might have saved this patient.⁷⁶

CASE XLIX. Male, age fifty-two. Epigastric pain of

three days' duration was followed by violent exacerbation. No vomiting. Six hours later the abdomen was tense, rigid, almost motionless, with complete absence of liver dullness in the line of the nipples. A diagnosis of perforated duodenal ulcer was made and operation decided upon. Ten hours after the attack an incision was made through the right rectus and a clean-cut perforation was found at the junction of the first and second portions of the duodenum. There was intestinal injection but no well-marked peritonitis. The perforation was closed with two rows of sutures, the intestines were brought out and washed with sterile water. A gauze slip was passed to the site of ulceration and the cavity of the abdomen was otherwise closed. Recovery uneventful. The gauze plug was removed on the second day, and the bowels moved on the third day.⁷⁷

CASE L. Male, age twenty. Seven months previously an attack of epigastric pain and vomiting lasting two weeks. Sudden severe pain in the right side of the abdomen, accompanied by vomiting. A few hours later the tenderness was greatest over the appendix. Temperature 102°, respiration 48, pulse 118. Diagnosis of appendicitis. Twenty hours after the attack an incision over the appendix allowed the escape of a quantity of odorless gas and fluid. On account of feeble condition further operative attempt abandoned. Death in twenty-four hours. Autopsy showed a perforation in the duodenum, anterior wall, just beyond the pylorus.⁷⁸

CASE LI. Male, age forty-five, a moderate drinker. Four years previously a similar attack. While in perfect health was seized with severe pain in the right side of the abdomen, referred to the iliac region. A few hours later the abdominal wall was tense, without distention or loss of liver dullness; tenderness over the appendix; temperature 100°, respiration 32, pulse 104. Diagnosis of appendicitis. Thirty-two hours after the attack an incision over the appendix evacuated considerable turbid serum. The appendix was normal. The peritonitis was most marked on the right side, and was followed up the colon to the hepatic region, but no cause for it could be found. The whole abdomen was flushed and drains were placed in the duodenal region and in the pelvis. Death in seven days. Autopsy showed a general exudative peritonitis, without free fluid. In the duodenum, anterior wall, just below the pylorus, were a perforated ulcer and the scar of a healed one.⁷⁹

Original Article.

THE IDEAL RATION FOR AN ARMY IN THE TROPICS.*

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SINCE the amount and character of food required for the preservation of health and vigor is influenced not only by climate but also, to a certain degree, by body weight, age, race, custom of living and other varying factors, it will be premised at the outset that the army above referred to is composed only of white troops, preferably drawn from the same regions and recruited under the same physical requirements as are the military forces of the United States. It is fur-

* This essay was unanimously awarded the prize of \$100, offered by Dr. Louis L. Seaman, late Major and Surgeon First United States Volunteer Engineers, through the Military Service Institution, Governor's Island, N. Y., for the best discussion of the above subject. The judges were Col. John F. Weston, Acting Commissary-General, U. S. Army, Lieut.-Col. Charles Smart, Deputy Surgeon-General, U. S. Army, and Lieut.-Col. William E. Dougherty, Seventh U. S. Infantry. The competition was open to all commissioned officers of the army, navy and volunteer forces.

⁷³ Perkins and Wallace: *Lancet*, 1900, i, p. 458.

⁷⁴ Bolton: *Medical Record*, 1900, vol. lvi, p. 494.

⁷⁵ Loc. cit.

⁷⁶ Johnson: *American Surgery*, 1899, vol. xxx, p. 634.

⁷⁷ Wright and Bury: *Lancet*, 1899, ii, p. 215.

⁷⁸ Elliot: *Boston Medical and Surgical Journal*, 1900, vol. cxlii, p. 41.

⁷⁹ Loc. cit., p. 42.