JEJUNOSTOMY WITH JEJUNAL ALIMENTATION *

By John A. Wolfer, M.D.
of Chicago, Ill.

During the past fifty years many attempts have been made to nourish the devitalized patient who was unable to take or retain foods by means of a jejunostomy with jejunal alimentation. The procedure was also advocated as a means to rest the stomach in the presence of ulceration. The largest percentage of these efforts have been disappointing because of the lack of a thorough understanding of the principles of gastro-intestinal physiology. Various types of foods have been used but in the majority of instances undesirable results followed because the food substances were usually irritating to the jejunal mucosa, leading to cramps, nausea and vomiting and diarrhœa. Since the procedure was being employed in patients who were in extremely poor condition, it was usually the lethal factor in the tragic end.

One of the earliest jejunostomies for feeding purposes was done by Pearce Gould[9] on August 8, 1885, and reported before the Clinical Society of London on November 27, 1885. The operation was performed under a carbolic spray, the wound being dressed with salicylic wool, for a carcinoma of the pylorus. The patient was fed cream and peptonized tea. The author advocated the use of the procedure preferring it to gastroenterostomy because of the high mortality rate of the latter (73 per cent.). He believed that it placed the stomach at rest and that the food was introduced into a part of the alimentary canal where digestion and absorption were very active. He called attention to the fact that the food should be given slowly and in liquid form early and later thickened. At the same meeting Golding-Bird[8] reported a similar case and announced the observation that when a pint of food substance was introduced into the jejunum indigestion took place but when only ten ounces were given no symptoms were manifested. He concluded that perhaps the rapid emptying of the stomach through an open pylorus caused indigestion. It is interesting to note how little progress was made in this valuable procedure in the following forty-five years.

Benedict[3] in 1898 made a distinct plea for jejunostomy and pointed out the fact that a jejunal feeding afforded rest to the stomach. He asked the pertinent question: "Why is it that it has never been seriously considered that the withdrawal of irritation from a gastric cancer is just as good treatment as the same principle applied to other cancers at an ineradicable stage?" He pointed out that in cases of carcinoma of the cardia, gastrostomy allows irritation by peristalsis, hydrochloric acid and the impact of food particles and that only one in five can perform proper digestion or prevent improper fermentation. He further states: "The stomach is not a particularly valuable

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organ but like some persons owes its reputation for importance to its capacity of making trouble when it is disturbed."

In 1902 Moynihan[22] reported two cases of extensive carcinoma of the stomach on which he performed jejunostomy for alimentation. He observed that life was made tolerable and prolonged and that thirst and starvation were banished. There is again a comparative silence until in 1912 W. J. Mayo[18] and Mayo-Robson[19] mention the procedure. Mayo stated that jejunostomy gives rest to the stomach and is a competitor to gastrostomy in cases of œsophageal obstruction and in extensive peptic ulcers which cannot be excised. He also believed that it was a valuable procedure in accidental injuries of the stomach and as a safety factor in extensive resections. He used milk, eggs, ground meat and carbohydrates as food elements and noted no ill effects. Mayo-Robson[19] advocated the procedure in widespread carcinoma of the stomach, in extensive cicatricial contraction of the stomach due to caustics, in chronic ulcers of the stomach giving rise to hæmorrhage, pain, vomiting and malnutrition in patients too ill for gastrectomy, in duodenal ulcers in stout patients who have had recent violent hæmorrhages, in jejunal and gastrojejunal ulcer where the patient is too ill to bear extensive operation, in recurring hæmatemesis failing to yield to ordinary treatment and in cases presenting persistent vomiting threatening life as in severe and sometimes fatal vomiting of pregnancy where no food can be retained. He stated that he felt that the procedure had not received the attention it merited.

In 1919 Eiselsberg[6] reported two cases upon which he performed the operation for feeding purposes. One was for a jejunal ulcer. Six years later in spite of poor nutrition incident to the war the patient was without symptoms. The other was a case of linitis plastica operated upon in 1902. That patient gained 32 kilograms in weight and died fifteen years later of carcinoma of the uterus. The report indicates that this patient was given jejunal feeding for five years and possibly during the entire remaining fifteen years of her life. Eiselsberg[6] used milk, bread, Nestle meal, beef tea, eggs, tropon, somatose and oil as feedings. In 1921 Downes[5] reported two cases of extensive ulceration of the stomach in which he performed jejunostomy and used jejunal feedings. The first case was fed eight months with a gain of thirty-six pounds in weight with marked improvement in the radiological findings. The second case with an ulcer of the fundus the size of a hand after three weeks gained 1,000,000 in the red-cell count. The treatment was being continued in both cases. Walker[27] in 1922 proposed indications for jejunal feeding similar to those stated by Mayo-Robson[19] in 1912.

During the past ten years a number of articles have appeared advocating jejunal feeding and calling attention to the great benefits derived when used in selected cases. Barber[1] in 1933 reported unfavorable results calling attention to a very high mortality rate and gross changes in the jejunal mucosa. He advocated a special form of jejunostomy which he believed would overcome the possibility of leakage and a subsequent peritonitis. He stated that he does not believe that the elaborate preparation advocated by Ivy is neces-

sary but his results indicate that had he followed the preparation as outlined by Ivy his results would have been less disastrous.

The Effect of Jejunal Alimentation Upon Gastric Secretion and Motility. In 1927 Henning[10] demonstrated some interesting findings upon the human by introducing a tube into the stomach and another into the duodenum and jejunum. When pabulum was introduced into the duodenum it stimulated gastric secretion and there was a moderate rise in the acid curve. With the introduction of the same substances into the jejunum there was a fall in the acid curve and the total amount of secretion (Charts 1 and 2). To Ivy and his co-workers is due the credit for a thorough study of the subject and the perfection of a method of feeding and a physiological diet which prevents intestinal irritation and which will maintain a nutritional and water balance over long periods of time, likewise preventing deficiency states.

In 1931 Scott and Ivy,[24] realizing the possibility of preparing a pabulum

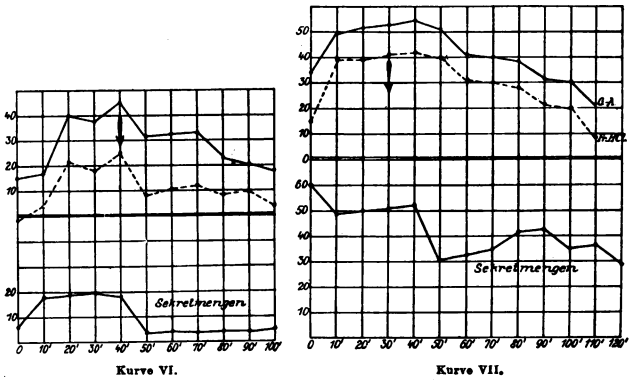

CHART 1.—Curve VI. Patient, aged twenty-nine, with duodenal ulcer. At arrow fifty cubic centimetres of milk was introduced into the jejunum. (From Henning: Arch. f. Verdauungs Krankheiten.) Curve VII. Patient, aged twenty-five, with habitual constipation (hypersecretion). At the arrow fifty cubic centimetres of a 10 per cent. white meal mixture was introduced into the jejunum. (From Henning: Arch. f. Verdauungs Krankheiten.)

which would not be irritating to the intestinal mucosa, began experiments upon the dog. They reasoned that theoretically any method of jejunal alimentation should involve the following physiological principles: (1) a bland non-irritating easily digested pabulum containing all the essential food elements, (2) it should be administered slowly simulating the manner of emptying of the stomach. After many trials they found that a mixture consisting of water, 3,000 cubic centimetres; cane sugar, 150 Gm.; peptone (dried), 100 Gm.; wheat flour, 300 Gm.; whole milk, 2,000 cubic centimetres; and cream, (20 per cent. fat) 1,000 cubic centimetres, along with sufficient salt to maintain the chloride balance and such vitamins as cod-liver oil, viosterol, yeast and the citrous juices would maintain an animal in proper nutritional state for many months. Using this as a test pabulum Scott and Ivy[24] demonstrated upon the dog with a Pavlov pouch that before feeding the mucous membrane of the pouch was red, secreting acid. After jejunal feeding the

mucous membrane became pale and dry. This latent period during which no acid was secreted depended upon the nature of the feeding and the distance from the duodenal junction at which the pabulum was introduced. When undigested food such as the Ivy pabulum was used the latent period was longer than when partially digested food was used. They believed that the latent period of from two to four hours was due to inhibition of the intestinal phase of gastric secretion. The intestinal phase of gastric secretion results in 400 cubic centimetres of secretion in twenty-four hours in a dog. Hollinger and Kelley[14] working in Ivy's laboratory have shown that continuous jejunal feeding over a period of nine hours of a bland diet (Ivy mixture) in the dog yields 21 cubic centimetres of gastric juice from a pouch. By adding atropine no acid was secreted. They have also shown by means of a balloon in the stomach that during a period of nine hours of continuous jejunal feeding there were no hunger contractions. The gastric phase of gastric secretion was eliminated by withholding everything by mouth.

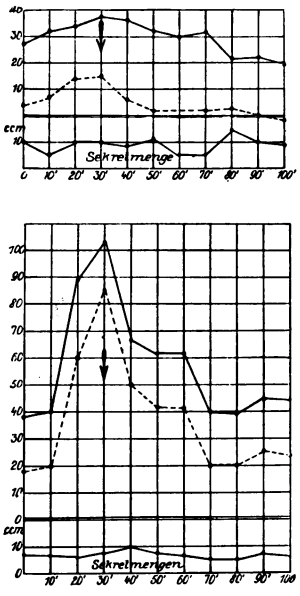

CHART 2.—Top.—Patient, aged twenty-two, with duodenal ulcer. At arrow forty cubic centimetres of egg was introduced into the jejunum. (From Henning: Arch. f. Verdauungs Krankheiten.) Lower.—Patient, aged twenty-seven, with duodenal ulcer. At arrow 100 cubic centimetres of a pabulum was introduced into the jejunum. The pabulum consisted of fifty Gm. of sugar, fifty Gm. flour, five eggs, forty Gm. butter and 1,000 cubic centimetres of milk. (From Henning: Arch. f. Verdauungs Krankheiten.) Note the marked fall in the acid curve when a composite mixture similar to the Ivy pabulum was used.

These observations would prove that jejunal alimentation when adequate reduces an excessive acid gastric secretion; in fact the acid secretion may be entirely eliminated with the addition of atropine, also with continuous feeding hunger contractions are inhibited thus putting the stomach at rest.

Technic of Jejunostomy.—When the operation is done primarily for a jejunostomy a left transrectus incision is made. Following a rapid exploration of the abdominal viscera, a loop of the jejunum about ten inches from the duodenojejunal junction is isolated. A stab wound is made through the antimesenteric wall of the gut and a twenty-two or twenty-four sized catheter is inserted at least eight inches into the lumen of the jejunum. The catheter is fixed to the intestinal wall by two catgut sutures at the site of the jejunal opening, the catheter being then buried in the wall of the jejunum by the Witzel method. The catheter is then drawn through a liberal opening in the omentum and brought out of the abdomen through the lower end of the abdominal incision. The jejunum where the catheter emerges is fixed to the abdominal wall by a catgut suture. The remaining portion of the abdominal incision is then closed in the usual manner.

In the event that the jejunostomy is done as a complementary operation when a right rectus incision has been made, the catheter is drawn through

a stab wound of the left rectus muscle about three inches below the costal margin.

It is important that the catheter extend well down (eight to ten inches) in the lumen of the jejunum so that the pabulum when introduced is well away from the site of perforation of the jejunum. The peristalsis of the gut carries its contents onward and there will be no leakage about the wound. It has been observed that if the pabulum is introduced into the jejunum near the entrance of the catheter, very soon some of the pabulum will make its appearance about the tube. The digestive juices will begin to erode the abdominal wall causing more loosening of the catheter and more leakage thus defeating the purpose of the procedure. In case the catheter is expelled some days after the jejunostomy, it should be cleansed and introduced again. Before introduction it should be well lubricated with some

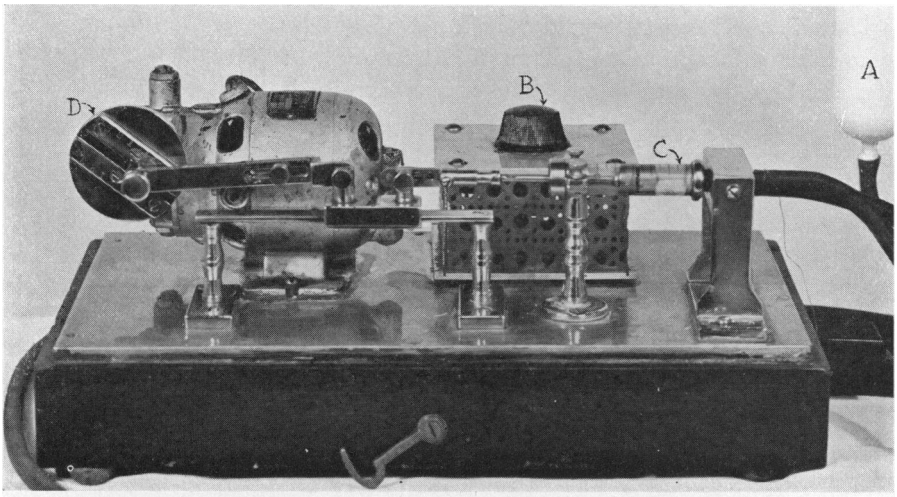

FIG. 1.—Electrically driven pump for jejunal alimentation. (Designed and built by the Department of Physiology of Northwestern University.) (A) Glass cylinder containing the pabulum. (B) Rheostat control to regulate the speed of the motor. (C) Graduated glass syringe with metal piston. (D) Eccentric mechanism to regulate the length of the piston stroke. When the rheostat is regulated so that there are sixteen revolutions of the eccentric wheel per minute and the eccentric is adjusted so that the syringe delivers .25 cubic centimetres per stroke, it will require fifteen minutes to introduce 60 cubic centimetres of the pabulum. By increasing the speed or the length of the piston stroke the amount delivered will be proportionately increased.

lubricant like KY jelly. No force should be used, only gentle pressure and very soon the peristalsis of the gut will draw it along. Hess[12] has shown experimentally with a balloon, cord, pulley, and bag that the peristaltic pull, eighteen centimetres from the pylorus is 228.5 Gm.

In my experience I have had no death directly attributable to the operation, however, one patient in a state of alkalosis with a wild delirium due to a large gastric ulcer died soon after the operation. The cause of death was attributed to avertin poisoning even though the dosage of avertin was only "basal." Peritonitis, intestinal obstruction and jejunal ulceration or gross signs of irritation were never encountered.

Jejunal Feeding.—Scott and Ivy[25] have stated that in jejunal alimentation

certain physiological principles should be observed. One is that the pabulum be introduced slowly simulating the manner of emptying of the stomach. Many attempts have been made to perfect such a delivery technic but most have been failures. After a number of trials there was built in the machine shop of the department of physiology of Northwestern University an electrically driven pump which will deliver any quantity of pabulum desired during a specific period of time (Figures 1 and 2). The rate at which the pabulum is administered can be nicely regulated, drop by drop giving from 25 to 250 cubic centimetres or more per hour. The tube leading from the pump to the jejunal tube may be coiled over the abdomen of the patient thus affording sufficient heat to bring the pabulum to a temperature which is desirable.

Three to four hours after the jejunostomy water is slowly introduced through the tube giving 100 cubic centimetres or less per hour. The drip method may be used. In twelve hours pabulum feeding is begun. The standard Ivy pabulum (Table I) modified to meet the demand of the

TABLE I

Formula of Ivy Pabulum

Vitamine Feeding—added to the regular feedings once daily

	Measure	Weight in Grams	Carbohydrate	Protein	Fat	Calories
Orange juice	½ cup	100	10.0	1.0		
Egg	One			6.0	6.0	
Viosterol	3 drops					
Haliver oil	5 drops					
Harris yeast tablet	One					
			10	7	6	120

Jejunal Feeding

	Measure	Weight in Grams	Carbohydrate	Protein	Fat	Calories
Milk	1½ qt.	1,500	75.0	45.0	52.5	
Cream	1 pt.	500	20.0	15.0	100.0	
Sugar	¾ cup	150	150.0			
Flour	1 cup	120	90.0	13.0	1.5	
Peptone	½ cup	80		80.0		
Ringers	1,000 cc.					
Water	1,000 cc.					
			335	153	154	3,340

Dissolve sugar in water. Add peptone. After both sugar and peptone have been thoroughly dissolved in the water, heat for several minutes. Mix flour with part of the milk to a smooth paste. Mix peptone solution with flour and milk. Bring mixture to a boil quickly over a hot flame but do not allow to boil. Stir vigorously, keeping a sub-boiling point until it thickens to the consistency of a thick cream soup or thin flour paste mixture. Strain, cool. Keep in refrigerator.

* Or 2,000 cc. water, and 2 tablespoonsful salt.

individual case has been used by us. During the first twenty-four to forty-eight hours the pabulum is diluted with equal parts of water.

Feedings are given every hour during the day and night, the individual feeding requiring from fifteen to thirty minutes depending upon the amount and the time after jejunostomy. Scott and Ivy have shown that immediately after a jejunostomy the jejunum will tolerate only small amounts of the pabulum but that after some days from 500 to 600 cubic centimetres may be introduced in an hour without cramps or diarrhœa, however, they state that smaller feedings at more frequent intervals can be digested and absorbed more readily. The usual technic is to give fifty cubic centimetres of the

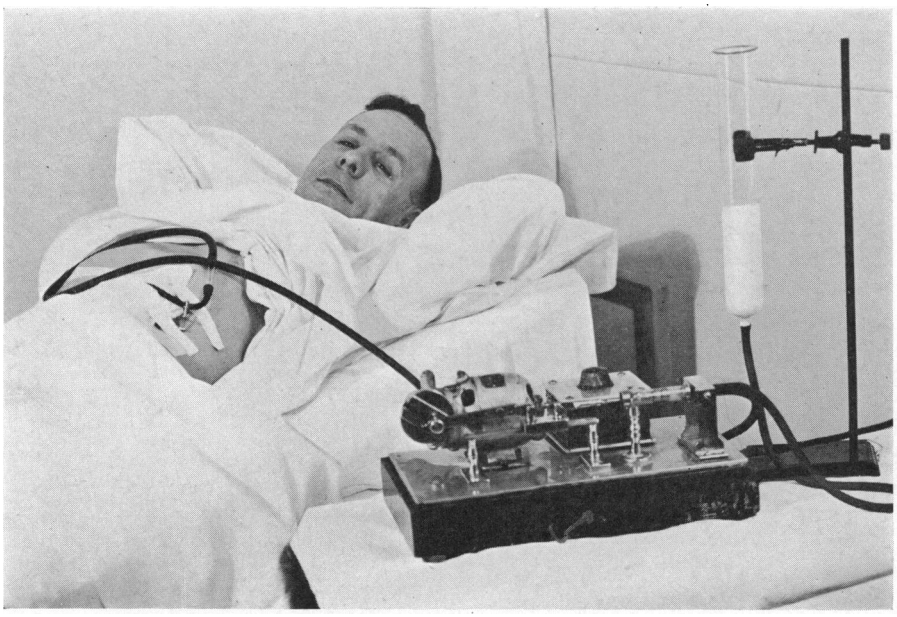

FIG. 2.—Electrically driven pump as employed in jejunal alimentation.

diluted pabulum hourly during a period of about twenty minutes for from twelve to twenty-four hours. The amount is then gradually increased to 100 cubic centimetres per hour. If this is well tolerated the amount is decreased and undiluted pabulum is administered, the feeding being cautiously increased so as to give the necessary caloric content. Occasionally during the first twenty-four hours it becomes necessary to give the feeding every second or third hour because of an irritability of the jejunum, however, in the majority of cases water may be used during the hours when no pabulum is given. After forty-eight to seventy-two hours depending upon the amount of reaction, the vitamine feeding is begun. Care should be exercised in the administration of the pabulum or vitamine feeding noting such symptoms as nausea, cramps or diarrhœa. Rapid feeding may cause nausea, vomiting or pain. A diet too rich in fats may lead to diarrhœa. Cane sugar is much better tolerated than glucose. In some instances the sugar content must be reduced

because of fermentation. The orange juice in the vitamine feeding occasionally leads to diarrhœa in which event it must be reduced in amount or omitted for several days or diluted lemon juice in ten to twenty cubic centimetres amounts may be substituted. It has been our experience that too rapid feeding is the most common cause for symptoms. The average case will tolerate 100 to 150 cubic centimetres of the regular pabulum per hour during the entire day and night without any discomfort after the fourth or fifth day. In the majority of cases nothing is given by mouth; in fact, for those patients that vomit, a tube is inserted into the stomach and frequent aspirations are made. Ulcer patients may be given atropine or tincture of belladonna so as to completely eliminate acid gastric secretion. It is interesting to note that when there is administered the full daily allotment of the pabulum, 3,000 to 3,600 cubic centimetres with the addition of some water the patient does not complain of hunger or thirst, the tongue and buccal mucous membrane becomes moist and clean and the breath is no longer offensive.

We have found that in some instances in which large amounts of gastric fluid are aspirated the introduction of from 200 to 1,000 cubic centimetres of the aspirations daily in divided amounts mixed with the pabulum improves the results of the feeding. Other substances may be added. In the presence of a biliary duct obstruction we have employed bile salts, bile and chrondroitin. With obstruction at the ampulla excluding pancreatic secretion, pancreatin may be used. Sedatives may be added to the pabulum when indicated. In the presence of diarrhœa caused by an excess of fats opium is a valuable agent. The teeth of the patient during the course of jejunal alimentation should receive careful attention. The time at which jejunal alimentation should cease will depend upon the condition for which the procedure is used.

At the conclusion of the jejunal feeding regime, selected food substances are given by mouth and a percentage of the jejunal feeding is withheld. The latter is necessary since a patient that receives 3,500 calories by tube will have little desire for food. As the patient tolerates more food by mouth less is given by tube so that within a required period of time all jejunal feeding can be withdrawn. Three or four days after all jejunal alimentation has been withheld and the patient is taking ample food by mouth without symptoms, the tube is withdrawn and the fistula will close within three or four days. Rarely is there enough drainage to soil a dressing. I have never had a continuously leaking fistula which demanded a closure.

In 1929, Eusterman[7] reported a case of avitaminosis following jejunal feeding for a large gastric ulcer. The diet employed was cooked cereals, occasionally orange juice, cream soup and milk and cream. The diet was not rigid. With the addition of vitamine D, giving scraped beef, fresh fruit juice and yeast, recovery ensued.

INDICATIONS FOR JEJUNAL ALIMENTATION.—(1) *Large Ulceration of the Stomach.*—Occasionally there are encountered cases with very extensive ulcerations of the stomach in which resection is impossible or fraught with great danger. It has been shown that correct jejunal alimentation will

markedly decrease or may completely abolish acid gastric secretion and allow rest to the stomach by reducing hunger contractions. By completely withdrawing food by mouth, the mechanical irritation due to food impact is also relieved; moreover, the patient can be nourished for a long period of time by jejunal alimentation affording ample time for the ulceration to heal.

The procedure has been recommended by Mayo-Robson,[19] Walker,[27] Hillman,[13] Heyd,[11] Downes,[5] Carson[4] and others. Scholtz and Baugsch,[23] Bardachzi[2] and Skeles, Jurgens and Gebhardt[15] and others have advocated the use of the tube allowed to pass into the jejunum after being introduced into the stomach, thus avoiding a surgical procedure. Jurgens and Gebhardt have treated in this manner fifty-one cases, six of which had gastric ulcers. They state that with pylorospasm, time must be allowed for the tube to pass into the jejunum. This at times requires several days. In the six cases the subjective symptoms disappeared, objectively four improved but only one gained in weight. The diet employed while similar to ours was not so well adjusted to the individual needs of the patient and possibly accounts for the lack of gain in weight. It has been our experience that many of the patients with large irritable gastric ulcers will retain a tube in the stomach for days, due most likely to the pylorospasm and even though it finally passes into the duodenum or jejunum it seems to irritate the stomach to the extent that the physiological response of jejunal feeding is not elicited. The stomach continues to secrete and motility is not inhibited as when the tube is implanted into the jejunum.

The procedure is well exemplified by the following case report:

Mrs. M. A., aged forty-five, had been treated by Doctor Atkinson for over a year for a lesser curvature ulcer. She had been on a well regulated regime of alkalies and mucin with a controlled diet. She was admitted to Passavant Memorial Hospital on June 13, 1933, with a history that for two weeks she had had severe epigastric pains with almost continuous vomiting. She had lost considerably in weight, the tongue was dry. The vomitus contained free HCL. Röntgen films taken two months previously showed an addition shadow on the lesser curvature of the stomach. On June 14, 1933, a jejunostomy was performed bringing the jejunal tube through the abdominal incision which was made through the left rectus muscle. An exploration at the time revealed a large infiltrating ulcer on the lesser curvature near the cardia. The patient tolerated the feeding very well although at times she manifested intestinal irritability which required small amounts of opium. She was discharged from the hospital on July 8, 1933, at which time she had gained in weight and strength. The feedings were continued at her home. In October, 1933, while still on jejunal feeding she appeared as a normal individual. On January 4, 1934, she died very suddenly from heart disease. At this time she was still being fed through the jejunal tube. At autopsy, the jejunum appeared normal. The Pathologist, Dr. H. R. Fishback, reported: "The stomach is hour-glass shape with a constriction near the centre having a flat measurement of four centimetres. The upper and lower pouches are about equal size, both moderately dilated and containing thin, slightly bile-stained fluid and mucus. On opening, a completely healed puckered scar is present in the lesser curvature with prolongation downward on the anterior and posterior surfaces. The wall is very little more thickened than elsewhere in the stomach and is pliable. No gross change is found in the remainder of the stomach."

This patient was satisfactorily nourished by means of jejunal feeding for approximately six and one-half months. She was comparatively free of pain, in fact she would have weeks with no pain whatever. She had a satisfactory gain in weight and strength and developed no deficiency reaction. The autopsy record clearly indicates a complete healing of the ulcer.

It has been our experience that the subjective symptoms are very promptly relieved following the administration of the pabulum; however, it must be observed that during the early period of feeding the pabulum must be given slowly and in amounts tolerated by the individual patient. Atropine or belladonna is a valuable adjunct in the cases which have a high acidity since it has been shown experimentally that the acid gastric secretion can be completely abolished in this manner. Care must be exercised in the amount of butter fat and orange juice administered since these substances have a tendency to irritate the intestinal mucosa in some cases. In fact the diet as stated must be adjusted to the individual's need.

(2) *Carcinoma of the Stomach.*—As far back as 1885 Gould and Golding-Bird recognized the rationale of jejunostomy with jejunal alimentation for inoperable carcinoma of the stomach. In 1898 Benedict made an ardent plea for the procedure and gave excellent reasons for the procedure. Heyd, Mayo-Robson, Walker, Mayo and Moynihan have advocated and used jejunal alimentation in carcinoma of the stomach, in some instances with success, at other times failure resulted from improper diet.

Golding-Bird and Benedict pointed out so clearly that the procedure relieved the stomach of irritation, allowed for rest and introduced the food into a portion of the gastro-intestinal tract where it could be digested and absorbed. They referred to the fact that a diseased stomach could not digest or empty food elements properly and that placing food into the stomach did not benefit the patient but increased his discomfort. Subsequent studies have verified these conclusions. It is remarkable how quickly pain is relieved in cases of carcinoma of the stomach after jejunal alimentation is begun. There is a co-incident gain in weight and the general condition of the patient. This is well exemplified in the following case report:

Mrs. B. L., aged forty-six, was admitted to Passavant Memorial Hospital on October 17, 1932, with the history that for the past six months she had been vomiting. There was a progressive loss of strength with pain in the epigastric region. She had lost sixty-five pounds in weight. The symptoms were first noticed one year before her entrance into the hospital. Upon examination a mass could be felt to the right of the umbilicus. She was markedly emaciated and could retain no food. She had been studied in the out-patient department of Northwestern University, where a diagnosis of extensive carcinoma of the stomach had been made. She was operated upon on October 18, 1932, at which time her upper abdomen was explored. The entire stomach seemed to be replaced by an irregular massive infiltration of rubbery consistency and large extra-gastric masses could be felt. A jejunostomy was done using a No. 24 catheter, which was brought out through a stab wound on the left side of the abdomen. She had very little reaction from the operative procedure and water was introduced a few hours after the operation. On October 19 the pabulum was started. On the third post-operative day she was free of pain and felt unusually well. She was discharged

from the hospital on October 29, 1932, at which time she was free of pain, had gained in weight and expressed the opinion that she was going to get well. The feedings were continued in her home, using a funnel and a pabulum prepared by her daughter under the supervision of the hospital dietitian. She lived approximately nine months after the jejunostomy, during which period she was for the most part comfortable. Vomiting was a disagreeable symptom although she was free of hunger and thirst and complained of little pain until just before death. It is my opinion that improper administration of the pabulum accounted for the gastric unrest.

The most distressing symptoms of inoperable carcinoma of the stomach, pain, hunger and thirst can be controlled better by jejunal alimentation than by any other means at hand today. We have noted that the patients gain in weight and are comparatively comfortable until shortly before death, which usually results from metastases in vital organs, the exitus being at times very sudden. This phenomenon would indicate that the loss in weight in the presence of carcinoma is due to a nutritional disturbance and not to a cancer toxin.

The technic of feeding in the presence of a carcinoma of the stomach varies somewhat with that ordinarily employed. The food tolerance should be very gradually built up. Due to the excessive pre-operative vomiting, the introduction of pabulum into the jejunum is likely to stimulate the vomiting reflex. The amount of pabulum should be less than ordinarily used and the time consumed in administration longer. Fats are not tolerated as well as carbohydrates. However, with care the tolerance can be built up to the level usually employed in jejunal alimentation.

(3) *Carcinoma of the Lower End of the Œsophagus.*—There remains a question whether a jejunostomy is preferable to a gastrostomy in high œsophageal carcinoma. However, I am convinced that in the presence of low œsophageal carcinoma, jejunal alimentation is far superior to gastrostomy feeding. Epigastric pain can be for practical purposes completely eliminated, the nutrition of the patient remarkably restored and maintained. It has been noted that after several months of jejunal alimentation with complete rest to the œsophagus, the patient is able to take sufficient liquids by mouth to satisfy the natural desire for mouth feeding, the caloric intake being maintained by the jejunal route. In low œsophageal carcinoma metastases frequently occur along the lesser curvature of the stomach or even the cardiac end of the stomach may be involved. Under such conditions the stomach is not the ideal place to introduce food. A secondary pyloric spasm provokes vomiting at times and peristalsis causes pain. These symptoms for the most part can be overcome by jejunal feeding.

CASE REPORT.—J. W., aged seventy-five, was admitted to Passavant Memorial Hospital on April 19, 1933, with the diagnosis of carcinoma, obstructive in type, of the lower end of the œsophagus. Over a period of two months he had gradually given up eating solid foods because of the inability to swallow. During the few days or week before entering the hospital he could take only a limited amount of liquid because of regurgitation. He complained of pains in the chest and upper abdomen referred to the back and there was evident considerable loss of weight. Röntgen ray findings were

characteristic of œsophageal carcinoma. On April 20, 1933, the abdomen was explored. The stomach was retracted under the left costal margin and a mass about five centimetres in diameter could be felt overlying the large vessels above the lesser curvature of the stomach. The cardia seemed fixed as if by an infiltrating growth. A jejunostomy was performed using a No. 24 French catheter. The catheter was drawn through a stab wound of the left rectus muscle. At 5 P.M. on the same day plain water was introduced into the tube at the rate of twelve cubic centimetres per minute, twenty minutes on and forty minutes off. At 3 A.M. because of distention and pain the water was stopped for a while. On the 21st of April the pabulum feedings were begun very cautiously, using 50 cubic centimetres of diluted pabulum per hour but giving the pabulum only every third hour. The water was continued. By April 25, 100 cubic centimetres of undiluted pabulum were being given in thirteen minutes every hour. On May 8, 1933, 200 cubic centimetres of the pabulum were given each hour without discomfort. After the first week the chest and epigastric pain had disappeared and the patient required no sedatives in spite of a far advanced arthritis which was then the chief cause of discomfort. He passed a comfortable summer. In September he began to fail and was confined to his bed most of the time. It is interesting to note that on October 1, 1933, he developed a carbuncle over the sacrum. Under hot boric compresses and phenolization, complete recovery ensued. This may be a criterion of the nutritional status of the patient. By October 17, 1933, he was failing rapidly and began complaining of some pain but he never gave me the impression that great pain was present. He died suddenly on October 25, 1933, after a convulsion. The autopsy revealed an ulcerating, obstructing carcinoma of the lower end of the œsophagus with metastatic carcinoma of the regional lymphglands, lungs, liver, small intestines, kidneys and adrenals.

In this instance a patient with extensive carcinomatosis was kept comfortable for many months. In fact, during the entire summer he was up and about and fully expected to regain his former health, this in spite of the fact that he had been informed relative to his condition.

The technic in feeding is similar to that in carcinoma of the stomach. Care must be insisted upon during the early period of feeding. It usually requires three to five days to establish a maintenance diet, however, water can be given rather liberally after the first twenty-four hours. Medication may be added to the pabulum. In the case reported because of the arthritic pains, aspirin or small amounts of codeine were occasionally added to the pabulum.

(4) *Duodenal Ulcer with Acute Exacerbation Associated with Excessive Vomiting and Marked Nutritional Disturbance.*—In the presence of persistent vomiting, the nutritional state of the patient with duodenal ulcer becomes a vital problem. When large quantities of alkalies have been administered or even in the absence of alkaline therapy, alkalosis may develop and if the latter is not promptly controlled, a fatal issue results. In the majority of such cases the duodenal tube will not pass the spastic pylorus or there may be real obstruction in the duodenum which prevents the passage of the duodenal tube into the jejunum. In such cases jejunostomy will afford a means of nourishing the patient and supplying mineral and vitamine substances to maintain a proper nutritional and chemical balance. Moreover, the physiological effect of jejunal feeding as manifested by decrease of acidity, and elimination of hunger contractions favors healing of the ulcer.

CASE REPORT.—A. I., male, aged forty-two, had been a patient in the out-patient department of Northwestern University under treatment for duodenal ulcer. He was admitted to Passavant Memorial Hospital on October 10, 1932, with the history that for six days he had complained of frontal headache, nausea and vomiting following intake of any food or water, and epigastric distress. He was stuporous. His blood-pressure was normal and the carbon dioxide combining power was 87.6. Following the administration of 600 cubic centimetres of .9 per cent. ammonium chloride solution intravenously he displayed some improvement. Large amounts of fluid were aspirated from his stomach, the first aspiration showing free hydrochloric acid but later there was none present. He was given glucose solution intravenously and salt solution subcutaneously. The following day the carbon dioxide combining was 98.8. Every effort was made to control the alkalosis and nourish the patient without results. On October 14 a jejunostomy was done and immediately feeding was begun. He received approximately 3,300 cubic centimetres of pabulum daily, however, the carbon dioxide combining power of the blood plasma fell very gradually. On October 24 the carbon dioxide combining power had fallen to 40.9 and the blood chlorides which were 295 on October 18 were 485. The patient began presenting symptoms of uræmia and died on October 29, 1932. The blood urea nitrogen rising to 219 before death.

It is evident that in this case the alkalosis was well established and present a number of days before a jejunostomy was done, however, it was brought under control but too late to prevent fatal kidney damage. The blood chlorides were re-established and nutrition established. It is reasonable to assume that had the jejunostomy been done several days earlier the fatal termination might have been prevented.

In those cases in which large amounts of gastric fluid are aspirated from the stomach we are now in the habit of instilling fractions into the jejunum, the amount depending upon the amount of acid present in the fluid aspirated. We have used as much as 1,600 cubic centimetres in twenty-four hours often with beneficial results.

Mensing[20] has used jejunal feeding in fifty-four cases of duodenal ulcer. Eighteen were of the bleeding type, six were acute perforations and nine were of the chronic perforating type. In forty-three cases he removed the appendix and in thirteen cases the gall-bladder was removed. All cases had had at least three courses of good medical management before the jejunostomy was done. He reports excellent results.

Jejunal feeding has been used in bleeding duodenal ulcer by a number of surgeons. There seems little question but that it offers an ideal means of resting the duodenum and supplying the patient with adequate nourishment over a period of time which is sufficient for healing of the ulcer to take place.

(5) *Gastrojejunal Ulcer.*—In the majority of cases of gastrojejunal ulcer the patient is in poor physical condition due largely to prolonged starvation and excessive vomiting leading to a deficiency state. Medical treatment as a rule is of little permanent benefit. The operative treatment is associated with great danger because of the length of time required and the poor condition of the patient.

With jejunostomy and jejunal feeding the patient can be fed for a sufficient period of time to establish a nutritional balance and allow for the inflammatory reaction about the stoma to subside. In the event that an

obstruction at the stoma results the operation can be performed at a time when the patient is in good physical condition. Much of the inflammatory œdema will have disappeared and a resection if needed will be infinitely easier with decidedly less danger to the patient.

(6) *Complementary Jejunostomy.—After gastroenterostomy*—In those cases of pyloric or duodenal obstruction which are associated with continuous vomiting, marked loss in weight and dehydration, a gastroenterostomy is often followed by a continuation of the vomiting and since the patient is already devitalized a fatal termination is too often precipitated. In such cases a jejunostomy will provide a means of supplying water and nourishment over a period of days. A stomach tube in place with frequent aspiration will keep the stomach empty. Usually within a period of four to five days the nausea will subside and the stomach will retain fluids and discharge them into the jejunum through the gastroenterostomy stoma. Moreover, the rest to the stomach and high jejunum will favor healing of the anastomotic suture line.

CASE REPORT.—A. A., female, aged sixty-three, was admitted to Passavant Memorial Hospital on March 30, 1934, with a history of six weeks of persistent vomiting. A diagnosis of subtotal duodenal obstruction was made. She had lost about thirty pounds in weight. She had continuous vomiting, evacuating from fifty to 200 cubic centimetres of fluid every few hours. She was operated upon March 31, 1934. A cicatrizing mass was found in the descending portion of the duodenum and a posterior gastroenterostomy was done. At the conclusion of the gastroenterostomy a tube was implanted into the jejunum and brought through a stab wound on the left side of the abdomen. During the first eighteen post-operative hours 1,900 cubic centimetres of water was introduced into the jejunum through the tube without discomfort. Pabulum feedings were then begun and gradually increased. A tube was introduced into the stomach because of a continuation of the vomiting. The amount of aspiration gradually diminished and the patient was without complaint. The bowels moved daily and the abdomen was soft with no distention. On the sixth post-operative day while she was receiving 100 cubic centimetres of pabulum and eighty cubic centimetres of water every hour without discomfort, she died very suddenly from a pulmonary thrombosis.

This patient was seen by me one-half hour before her death, at which time she told me she felt splendidly. At no time did she complain of thirst or hunger. Had it not been for an unfortunate complication which was not to be prevented a complete recovery would have resulted since the obstruction without doubt was caused by a cicatrizing ulcer.

Aside from the fact that the patient can be nourished after the gastroenterostomy, relief from thirst and hunger makes the convalescence comfortable. It is interesting to note that the patients do not complain of thirst or do they demand food if an adequate feeding regime is established.

After gastric resection.—In 1929, Kirschner[16] made a logical plea for jejunostomy for feeding purposes after gastric resection. He called attention to the fact that such operations are usually done on elderly patients who are poorly nourished and who do not tolerate further starvation and loss of water. He believed that subcutaneous and intravenous administration of water is liable to overload the heart also that it is difficult to maintain a water balance by rectal administration. Rectal feeding is of little value and a

proper nutritional state cannot be maintained by intravenous administrations of sugar. At the best only from 200 to 600 calories can be given the patient who demands at least 2,000. In gastric resection it is possible to maintain the nutritional and water balance and at the same time keep the stomach at complete rest by jejunal feeding, moreover, it offers a protection against leakage due to cutting of the sutures especially in anastomosing the gut to a very small gastric stump. It also lessens the danger of hæmorrhage. Kirschner refers to the post-operative atony of the stomach which comes on from the fifth to the seventh post-operative day which can be relieved only by jejunostomy. In his opinion these patients die not because of retention of fluids in the stomach but because of starvation and lack of water. Kirschner in 1929 had employed the procedure in sixty cases with good results. There seems to be no question but that the mortality rate of gastric resection can be materially reduced by employing this procedure in selected cases.

Miscellaneous Cases.—Jejunostomy should be employed in a variety of cases in which starvation and the lack of water intake play a part. When an operation is performed upon a patient in which vomiting is present and is liable to persist for a number of days, jejunal feeding may be carried on to a material advantage to the patient.

CASE REPORT.—M. K., male, aged sixty-nine, was admitted to Passavant Memorial Hospital on December 5, 1932 on the service of Dr. N. S. Davis, III. Because of persistent vomiting of bloody material, hiccough and pain in the abdomen a tentative diagnosis of carcinoma of the stomach was made. Because of the critical condition of the patient a Röntgen study could not be made. He was given supportive treatment, physiological salt solution subcutaneously and glucose intravenously. With the relief of the dehydration he improved somewhat, however, the vomiting of "coffee ground" material, hiccoughing and pain continued. After several remissions on December 18, 1932, an exploration of the abdomen was done. A large swollen pancreas with fat necrosis was found. The pancreas was drained and a jejunostomy was performed, the tube being drawn through a stab wound in the left side of the abdomen. The patient tolerated the operation very well. Feedings were begun in the usual manner. The stitches were removed on the ninth post-operative day and the following day the wound was widely separated. In the depth of the wound the stomach and intestines could be seen covered by an exudate. An attempt was made to do a secondary closure but on the following day the edges again were separated. The patient was in a stuporous condition, however, he was taking the feeding without any difficulty. A pancreatic fistula developed and the pancreatic juice was rapidly digesting the abdominal wall. With suction and packing the wound with peptone gauze the process was finally arrested and the wound was tightly strapped with adhesive. The vomiting of bloody material in relatively small amounts continued and the patient's condition became very critical. However, the jejunal feedings were continued and all mouth feeding was discontinued. The patient lost weight very rapidly and was in a semi-comatose condition practically all the time. He developed a decubitus which was treated with tannic acid. Late in February, 1933, he became alert and began taking interest in his surroundings. He was comfortable and only occasionally asked for food. He stated that he was not hungry but that he would like to take food by mouth. On March 13, 1933, he was taking small amounts of food by mouth without vomiting or discomfort and the abdominal wound was healed. The amount of mouth feeding was very gradually increased and the jejunal alimentation decreased so that by April 12 the jejunal feeding was discontinued. He had gained materially in weight and felt well. The jejunal tube was withdrawn on

April 21, 1933, and the wound closed within three days. At no time was there any leakage. On April 3, 1933, he weighed 124 pounds and on April 27 his weight was 145½. He left the hospital on May 3, 1933, at which time he felt well and was taking a liberal diet without discomfort. When last seen in April, 1934, he had no complaint.* It cannot be disputed that this individual would have died had it not been possible to nourish him artificially for a long period of time.

(7) *Linitis Plastica.*—In cases in which the gastric wall is extensively involved in a process such as linitis plastica or extensive fibrosis such as after caustic burns the stomach loses not only the ability to secrete but has no capacity and no motility. In such cases some method must be employed to nourish the patient if life is to be sustained. Jejunostomy with jejunal feeding is the procedure of choice and has been employed successfully by Eiselsberg.

(8) *In Cases of Excessive Trauma to the Stomach.*—Occasionally there are instances of excessive injury to the stomach in which surgical repair is inadequate and the possibility of leakage is great. Jejunostomy puts the stomach to rest, reduces gastric secretion and allows for adequate feeding over a period of time which is sufficient to permit the stomach injuries to heal. W. J. Mayo and Heyd have advocated jejunal feeding in such cases.

(9) *Pernicious Vomiting After Gastroenterostomy.*—This condition has been mentioned under the heading of complementary jejunostomy, jejunostomy being advocated as a preventative, however, in some instances excessive post-operative vomiting is not contemplated and its occurrence is fraught with anxiety and danger. With jejunostomy the patient can be fed for a long period of time while the stomach can be kept empty by intermittent aspiration. The mineral and chemical balance as well as water and nutritional balance can be maintained while the tissues repair themselves. In the event a secondary operation becomes necessary because of obstruction at the stoma, the patient will be in a state of nutrition which will enable him to withstand the procedure with little danger.

(10) *Extragastric or Duodenal Lesion Associated with Marked Nutritional Disturbance in the Presence of Excessive Vomiting.*—Jejunostomy as a complementary procedure in the surgical treatment of pancreatitis has been mentioned. There are other instances where the procedure may be utilized with good results. Suermondt[26] recommends jejunostomy in cases of long continued drainage from the common duct or gall-bladder when the patient is critically ill. He performed jejunostomy in three such cases and introduced the bile into the jejunum with satisfactory results. Care must be used in the introduction of bile into the jejunum because of the irritation likely to occur. It is wise to begin with small amounts and to gradually increase the amount as the tolerance develops.

Walker advised jejunal feedings in pernicious vomiting associated with pregnancy and reported a case in which it was used. Nausea and vomiting

* This patient was seen in September 1934 at which time he felt perfectly well and weighed 173 pounds. A rather extensive postoperative hernia caused him but little inconvenience.

ceased after four days of jejunal feeding. Mayo-Robson also advocated the procedure in similar cases. Miner[21] employed jejunostomy in a case of peritonitis after hysterectomy, first for drainage and later for feeding purposes. He administered 10 per cent. glucose solution into the jejunum with apparently good results, however, the work of Ivy clearly indicates that glucose is not tolerated as well as cane sugar solutions. One need not comment upon the fact that a partially paralyzed bowel will not tolerate much food substance and that great care should be exercised in the employment of jejunal alimentation in the presence of an impending paralytic ileus and should not be used when the bowel is paralyzed. Only harm can be expected in the latter instance.

It may be said as a generalization that in any condition associated with pernicious vomiting and in which the life of the patient is in jeopardy because of starvation and lack of water and in the absence of peritonitis or an ileus, jejunostomy may be indicated for the purpose of feeding. If the lesion producing the vomiting is amenable to eradication or spontaneous recovery, the life of the patient may be saved.

(11) *Selected Cases of Gastric and Duodenal Hæmorrhage.*—Occasionally cases are encountered in which because of persistent bleeding in spite of apparently adequate treatment and because of the critical condition of the patient precluding extensive surgery, jejunostomy is the procedure of choice. The stomach and duodenum are put at rest, the acid gastric secretion is reduced to a minimum and with the addition of atropine may be entirely eliminated and the patient can be satisfactorily nourished for a long period of time without inconvenience. Mayo-Robson in 1912 and Walker in 1922 advocated jejunostomy in such cases. Heyd in 1926 recommended jejunostomy for alimentation as a preliminary procedure to an excision of the larynx.

A survey of the experimental and clinical evidence justifies the belief that jejunostomy with jejunal alimentation is a relatively safe procedure, moreover, the accompanying laparotomy provides for a surgical exploration of the abdomen. A proper diet is necessary to prevent irritation and to maintain a nutritional, water and chemical balance as well as preventing a deficiency state. The warmed pabulum should be slowly introduced, simulating gastric evacuation. Proper jejunal feeding inhibits acid gastric secretion and with the addition of atropine may completely eliminate gastric secretion. Hunger contractions are prevented by continuous feeding. Such a state is highly favorable for repair of ulcerations and traumatic conditions and brings prompt and striking relief of pain in carcinoma and ulcer of the stomach. A wide range of usefulness for jejunal alimentation is evident, eleven conditions being suggested. Jejunostomy with jejunal alimentation should be more frequently employed as a means of nourishing the patient who cannot take or retain sufficient food to maintain an adequate nutritional balance and as a complementary procedure when it is necessary to nourish the patient immediately after an operative interference.

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