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Decompression methods in intestinal obstruction

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)ECOMPRESSION METHODS IN INTESTINAL OBSTRUCTION

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CONTENTS

Chapter I

INTRODUCTION

It is the purpose of this paper to review the methods and technics of Decompression Methods in Intestinal Obstruction. This addition to the armamentarium of the surgeon has been a recent development, yet one finds forerunners of the method back in the time of the Romans.

Intestinal obstruction, which is the primary indication for decompression methods, is a common disorder. There are always one or two patients with one or another type of obstruction in every hospital. One does not know when there will be a post-operative ileus, and if not ileus, then, perhaps nausea and distention, and one should always be prepared for the occasion should it arise.

In this paper an attempt will be made to first give a general discussion of the whole piece of intestinal obstruction; then a series of discussions on the different forms of treatment, starting first with the enterostomy, gastroduodenal decompression, intestinal decompression, and supportive therapy. By handling the material in the above manner, it is

is hoped that the reader will find that not just one method of treatment is justified in all cases, for they all have their indications and contra-indications. An attempt is also made to demonstrate that it is important to individualize the case at hand and that routine orders should be discarded in place of orders suitable for the individual needs. A very important item in this paper is an attempt to show that the fluid balance and salt balance of the patient is often the deciding factor in the determination of the prognosis and that more stress should be placed on the amount and character of the fluid aspirated in the course of the decompression.

Lastly, an endeavor will be made to impress this fact that, given the case of two similar methods with apparently equal outcomes, if the method is not completely satisfactory, then the choice of the method should be with the one that gives the greatest possibility of benefit to the patient and regardless of the amount of effort and patience that is required of the operator.

If any one of these aims is accomplished as a result of this paper, even in a single instance, then the efforts in preparation of the same have not been futile.

Chapter II

HISTORY

Unlike many of the "modern" advances in medicine, there is no reference made to the stomach tube in the classical writings of Greek or Arabian literature. The precursor of intestinal intubation goes back to the Roman era. During the reign of Emperor Claudius it was a common procedure to serve a drug, vomiton, which, according to Hemmeter (67), acted as an emetic. This was served with the dessert and the resulting emesis reestablished a sense of well-being which enabled the partakers to enjoy another feast. There was no set dosage to this drug, and the effect varied considerably from a sense of nausea to intractable vomiting.

Paine (121) states that the next developmental step was the insertion of the finger into the posterior pharynx in order to empty the stomach. A few years later there developed a more refined method of emptying the stomach, the use of the "pinna". This instrument consisted of a feather, or group of feathers which were dipped in a drug, iris or cypress oil, and was used to irritate the posterior portion of the throat. Paine (121) states that Claudius was supposed to have

been murdered by poison applied by the pinna.

During the Middle Ages the need for emptying the stomach from overfeeding no longer remained a problem, but the use of poison became the prime indication for the procedure. Hemmeter (67) states that Oribasius recommended the use of a long leather glove-finger, stuffed with wool and passed down the throat as effective. Mercurialis advised using a long leather strip, called a "laborum Vomitorium", in emptying the stomach. This was to be coated with an unappetizing substance, usually tannic acid, and then passed down the throat with one end remaining on the exterior. This also proved effective.

Hemmeter (67) finds that the next development occurred in the middle of the seventeenth century with the development of the "magenkratzer or magenraumer" in Germany. Paine (121) states that there a voluminous literature appeared concerning this instrument and indications for its use. These stomach brushes consisted of whale bone, arched in a half circle, and tipped with ivory, ivory and lead, tufts of horse hair, silk or linen. The instrument, according to Paine (121), was the source of heated arguments over the propriety of its use and in some communities, one was kept in the parish, while in others its use was forbidden.

The use of the first stomach tube and the purpose

of its use is unknown, but Paine (121) states that it was probably used before the time of Physick (127) who is credited with developing the stomach pump in 1800. Hemmeter (67) states that this was probably not done before the time of Van Helmont and his contribution of flexible leather catheters soaked in resin in 1648. Theodore Alcock (6) in his letter to the Recorder of the Medical Society in 1823, stated Boehare (1668-1738) was the first to suggest a flexible tube passed into the stomach for medical purposes.

John Hunter (73) in his "Proposals for Recovery of Persons Apparently Drowned", written in 1776, suggested the use of a hollow bougie or flexible catheter of sufficient length to go into the stomach to carry stimulating matter into it without affecting the lungs. He further stated that it would be advantageous to do this as the stomach is the seat of universal sympathy. In 1890 he reported a case of paralysis of the muscles of deglutition to the Society for the Improvement of Medical and Chirurgical Knowledge, and claimed a cure by an artificial mode of carrying food and medicine into the stomach.

Paine (121) quotes Hunter's description of the method.

"The Instrument made use of was a fresh

> eel skin of rather small size, and tied up at the end, where it covered the sponge, and tied again close to the sponge, where it fastened to the whole bone, and a small longitudinal slit was made into it just above this upper ligature. To the other end of the eel skin was fixed a bladder and wooden pipe, similar to what is used in giving a chyster, only the pipe was large enough to let the end of the probang pass into the bladder without filling the passage. The probang thus covered was introduced into the stomach, and the food and medicines were put into the bladder and squeezed down through the eel skin."

We must therefore credit the first recorded use of the stomach tube to John Hunter, but Paine (131) cites Alexander Munro III, who, in his graduation thesis from the University of Edenburgh in 1897, questioned the priority of John Hunter and stated that in 1767, his father used a flexible tube of coiled wire covered with leather to remove dangerously fermenting liquids and gases from the stomach of cattle.

Alcock (6) stated that Dupuytren and Renault followed Boerhare's suggestions and in 1803 perfected an instrument made out of leather. They published both a description of this and the results of animal interbation.

Physick (137), a professor in the University of Pennsylvania, about 1800, began advocating the use of a tube and a syringe in washing gases out of the

stomach. Dr. Dorsey, his nephew, tried this procedure in 1809 but was unsuccessful. Physick (137) related a case of an infant with morphine poisoning in which he used an ureteral catheter and syringe to wash the stomach.

In 1823, Sir Ashley Cooper (27,28,29) conducted a demonstration of a stomach pump by Mr. Jukes. Jukes had published a description of this the previous year in the "Gazette of Health". This was a two foot rubber tube about one-fourth inch in diameter. The distal end had several perforations and an ivory head at the tip. The description of 1822 had an elastic bottle of rubber but in the demonstration a syringe created by Mr. Reed was used. This syringe had two valves to eliminate the removal of the bottle from the tube.

This demonstration brought forth a tremendous storm of protest headed by Alcock (6) who cited several previous instances of the use of the stomach pump. Later the pump was "invented" in France and Germany. Paine (121) states that the only development in the next few years was by Arnott (7), when he suggested, in 1839, the use of siphonage instead of forceful suction.

Einhorn (35), gives Kussmaul credit for the discovery of the stomach pump. Paine (121) states that Bowditch of Boston acquainted himself with a model of

the stomach tube and pump. Bowditch also used this to aspirate empyema cavities. On his return to Europe, Kussmaue had Fischer, an instrument maker, make him one and in 1867 used it on a case of gastric dilation due to pyloric ulcer. He treated the girl by frequent lavages with the stomach pump with a recovery. During the next two years he treated twelve cases and in 1869 wrote his paper which was to popularize the clinical use of the pump and to have a profound effect on the treatment of gastric diseases. Lyon (93) states that it was this paper that was directly responsible for interest in gastric surgery and the entrance of Bilroth into this field. Immediately after this paper, improvements were made, and the possibilities of the use of the tube in diagnosis and treatment began to appear.

In 1870, Auerbach and Ploss independently developed recurrent tubes with double lumen, but these were large and caused considerable distress when they were used. Their use was advocated because of speed of lavage.

Lyon (93) gives Leube, 1871, credit for suggesting the possibilities of studying gastric physiology by use of the stomach tube and the use of test meals. He (Lyon) also states that in 1874 Ewald and Oser developed soft and pliable tubes which were of smaller calibre. They suggested cooperation of the patient, where as be-

fore, this was not asked, but a stiff hard tube was merely forced down the throat. A few thin pliable tubes were used before this, but always a stilet was employed in the insertion. This suggestion of co-operation was a real step in advance to the modern technic of insertion, and Paine (121) states that the modern tubes are practically of the same design, and the method of insertion the same as Ewalds. Of course, the tubes are made out of better rubber. Marcy (98), in 1883, noted that for best results with lavaging with double recurrent tubes, the efferent tube should be larger than the afferent because of the contents of the stomach.

We see that the first wish was to analyze the secretions of the stomach, and now we begin to notice a desire to go lower into the gastrointestinal tract. This was evidenced by the desire to get pancreatic secretion. Boas (10) introduced a tube into the fasting stomach, massaged the liver, and obtained fluid from the stomach which regurgitated from the duodenum which gave a pancreatic reaction. Boldreff (15), working in Pavloff's laboratories in Russia, noticed in animals with gastric fistulas that there was a regurgitation from the duodenum into the stomach when oil of fat was given. He suggested this for clinical use. Paine (121)

states that this method was neither practical nor reliable.

Following these early attempts at duodenal intubation Turck (141), in 1894, presented to the International Medical Congress at Rome, an apparatus called the "gyromele". This consisted of a revolving flexible steel cable, tipped with a spiral spring and sponge. The cable was encased in a rubber tube, and a drill arrangement was fastened to the proximal end in order to rotate the arrangement. The purpose of this instrument was to aid in the palpation and outlining of the stomach. Turck also claimed to have entered the duodenum, which is quite likely. This instrument was not universally accepted.

In an attempt to obtain pancreatic secretion by duodenal inturbation, Hemmeter (68), in 1896, constructed a balloon the shape of the stomach. This had a groove or canal along the lesser curvature in order to permit the passage of another tube into the duodenum. He proved entry into the duodenum by X-rays (131), and also claimed to have obtained pancreatic secretion. This method was cumbersome, and Einhorn (36) states that the main trouble with this method was that stomachs vary in size and shape and the balloon would not fit every stomach.

Einhorn (36) states that two years later (1898) Kuhn developed tubes with metal rings inside them to

prevent kinking and doubling. This was manipulated for a long time, until it was thought that it was in the duodenum. This was a difficult procedure, but more practical than Hemmeter's, who abandoned his method in favor of Kuhn's.

These were the starting attempts of the duodenal tube. Einhorn (36), in 1904, suggested the use of porcelain beads. He introduced them by mouth, and then sifted the stools and from this procedure determined intestinal motility. He then made hollow beads and used the same procedure to determine the digestive function. It was only a step from this to fastening a string of set length to the beads, and in 1908 he tested potency of the pylorus by this method. He held the beads at twenty and thirty inch depths and had an indicator in an agar base within their lumen in order to determine whether or not they were in the duodenum.

It was a simple step from the above beads to the development of a bucket arrangement. He (Einhorn) was able to obtain duodenal contents with this method. Its position was confirmed by X-ray studies.

The first intestinal tube was devised by Scheltma (133), in 1908, who gave the first description of intestinal intubation, first in animals and then later

in children. This tube consisted of a number eleven French scale tube with a bulbous distal extremity. It was introduced through the nares and required several days for passage into the small bowel, but he observed it at the anus later.

The next step followed by Einhorn was the development of an instrument which could by pushed over the string. This consisted of a thin rubber catheter and a pylorus dilator. He obtained duodenal secretions with this instrument, but it was disagreable and would not enter deep into the duodenum. The tip of this first tube ended in a bucket, but later he modified it by using a thin rubber tube ending in a perforated metal capsule of an olive shape. He let the stomach introduce this instrument into the duodenum instead of pushing it in. The next year (1910) he constructed a duodenal pump to aspirate the duodenum. He found that if the tube were too thin it was difficult to obtain fluid; and that if it were too thick, it was too clumsy and unpleasant(36). His suggestions for clinical use of this apparatus was in the treatment of acute dilation of the stomach, obstructions of the pylorus, and pylorospasm. He also had a pyloric dilator consisting of a rubber bag in a gauze envelope

which was collapsable but was capable of dilation.

Working independently of Einhorn, Gross (61), in 1909, developed a tube very similar to that of Einhorn's. His tube ended in a metal capsule which was about two times as heavy as Einhorn's. Its use depended on gravity as well as gastric peristalsis to enter the duodenum. Gross (62) claimed the best results when the patient reclined on the right side after swallowing the tube.

Einhorn (36), in 1909, reported a case of pernicious vomiting in which the patient could not be nourished by rectum due to diarrhea, the method of nourishment in those days. He used his tube for examination, and then left it in for ten days for nutritive purposes, with good results.

Following this period the literature becomes voluminous and Einhorn's and Grosse's principles spread to Europe and we find many developments, and improvements, in technic. Paine (121) states that there were about forty to fifty soft rubber tubes with a weighted tip. Hess (121), in 1912, described the use of a small Nelaton catheter for the duodenal intubation of infants. Because of the anatomical relationships, this could be carried out. One example of the tubes being constructed during this period was the tube designed by Palefski (125).

This was a gold tipped tube in order to allow gravity to carry the tube into the pyloric region. He suggested that as the tube reached the cardia of the stomach the patient should lie on his right side.

Einhorn (33) published a paper on "New Instruments for Duodenum and Small Intestine". In this paper he describes his "Duodenal Obturator" which was to close the lumen of the duodenum and thus permit injection of bismuth for roentgen films of the area. Another description of his "Intestinal delineator" was included in the paper. The third instrument that he advanced was a "Sectional Intestinal Examiner". This was to examine the mucosa of the intestine, and consisted of a three lumen arrangement with two small canals and one large. Two inflatable balloons were used. This tube was introduced in the evening before retiring. The next morning the middle balloon was inflated in order to shut off the duodenum proximal to the segment to be isolated, then the distal balloon was inflated. This permitted an isolated loop for aspiration.

The tube which was developed by Rehfus (138) in 1914, for the simple aspiration of gastric content has not been changed up to the present date, nor has

his method of analysis been modified to any great extent. This tube, however, has not replaced the Ewald tube in the lavage of the stomach.

From the period of 1918-23 Einhorn (37,38,39,40) published a series of articles which reviewed his method of duodenal intubation and methods of insertion. In the last two articles he discussed the "Treatment of Ulcerative Colitis thru Intubation". He observed his tube transverse the entire intestinal tract and appear at the anus. These tubes were the size of a number eight French catheter, and this small lumen did not permit rapid evacuation of the intestinal contests.

Levin (85), in 1921, designed a smooth tipped duodenal tube for adults. The advantages of this tube was found to be a passage through the tract could be accomplished. Another difference in construction from the previous tubes was that it was all one piece. This tube is the type of tube used in duodenal aspiration today.

All through the development of the intestinal tubes, especially in the later developments, speed in the passage of the pylorus has been the chief aim of the changes of designs and methods of intubation. Einhorn's tubes (38-40) required ten to twelve hours to enter the duodenum and three to four days to reach the caecum. Gross (62) claimed to be able to enter the duodenum by

gravity. Lippman (89), in 1914, studied the technic of the insertion of tubes and presented his own suggestions which will be discussed later.

An interesting aspect to the study of the intestinal tubes is the different clinical applications of procedure. As has been discussed above - Hunter (73) was interested in poisoning, while Kussmaul (36) was interested in the decompression of the stomach. Examination and analysis of the duodenal secretions was the prime purpose for the invention of duodenal tubes up to about 1920. Since that period their use as a therapeutic agent has increased. Gross (62) and Jütte (79) recommended duodenal decompression and lavage followed by oxygen insufflation for auto-intoxication and intestinal catarrh. Lyon (92) was chiefly interested in the non-surgical drainage of the full bladder with the use of duodenal tubes and magnesium sulfate installed through the tube.

Scheltema (132) in 1908 developed his tube for the treatment of intestinal parasites. Gnatt and Weist (60) in 1923, suggested its use in intestinal parasites. Simon (134) again in 1931 used intraduodenal instillations in the treatment of intestinal parasites. Along these lines, McDonald (94), in 1924, and Lieienthal (87), in 1928, suggested the introduodenal feeding in cases of

dysphagia, anorexia, and persistent vomiting. Young (171), in 1930, found the duodenal tube useful in feeding of kidney and uremic conditions. Loper (135), 1931, used the duodenal tube in treatment of hematemesis and found it useful. Einhorn (32) and Buckstein (19) were interested in treating peptic ulcers with the tube. Paine (131) states that Westerman, in 1910, treated 15 cases of peritonitis with resulting gastrointestinal stasis by continuous siphonage. Knavel (83) found the siphonage useful in peritonites, persistent vomiting, and suggested that closed systems be applied to the tubes. Meyer (100) found, in 1926, that by using siphonage and a duodenal tube in his post-operative cases, he was able to decrease nausea, vomiting and ileus.

Ward (161) made a valuable contribution to the development of the use of procedure when he advocates the use of a Jette tube through the nose and attached to an apparatus designed for continuous suction and lavage. In 1929 (162) he suggested that the suction method should be applied to cases with general peritonitis, and again in 1930 (163) reported its application to cases with acute dilation of the stomach. Like many other first suggestions, this was not promptly received. Stout (137) mentions the use of the duo-

denal tube in the treatment of intestinal obstruction and to increase the patient's general condition so that operation could be better tolerated.

As has been mentioned before, Ward's work was not followed by others throughout the country. It is true that by 1930 post operative siphonage was fairly common, but it remained for Wangensteen (147) to popularize the discovery of the principle of suction through a duodenal tube. The apparatus of Ward's paper incorporated and utilized all of the principles of Wangensteen's system, but as in the case of ether, the major credit must go to the individual who popularized the discovery (30). This technique of Wangensteen's found immediate general trial in treating intestinal obstruction.

In 1933, Paine and Wangensteen (124) showed that duodenal tubes draining the upper intestinal tract were not only effective by suction but they were more effectual than siphonage. Paine (120), in 1932, suggested suction as a prophylaxis against post operative nausea, vomiting, and distention.

Scheltema and Einhorn in 1908-1909 started intestinal intubation, and Einhorn, in 1913, recorded his triple lumen tube (33), but these were not popular. These took time and often failed to get beyond the duodenum. The tube had a small lumen which made aspiration diffi-

cult. Buckstein (20) published an article in 1930 suggesting an intestinal tube for the injection of a baruim mixture in order to study the loops by X-ray. These tubes passed 120 to 150 centimeters beyond the teeth, but they were slow and inconstant in action.

After trying the above tubes Miller and Abbott (102) in 1934 developed a double lumened tube, capable of passage through the nose and one which they hoped to be flexible enough to pass through the pylorus readily and along the duodenum rapidly. The tube had one lumen for aspiration of intestinal content, the other for inflation of a balloon which was used to propel the tube through the intestine by action of peristalsis.

Since this development of the tubes by Miller and Abbott and Wangensteen, every year finds more and more suggestions of tubes and procedures, but in the main, the principles are the same.

Chapter III

INTESTINAL OBSTRUCTION

Introduction.

The alimentary tract is a tube extending from the mouth to the anus, performing the process of digestion and absorption of food. Various foodstuffs are passed into the mouth in the crude state and are broken down by digestive processes. Then, portions of the digested food are absorbed at various levels in the canal. The absorbed products are transmitted to various parts of the organism for utilization in various body functions. This action is a highly specific one and cannot be taken over by other systems of the body.

The tract may be likened to a thin-walled cylinder running throughout the entire length of the body. In the normal organism there is adequate protection against fatal infection and other potential menaces. However, they are constantly threatening and are apt to prove dangerous wherever a weak spot occurs. Intestinal obstruction is one important phase of this mal-function of the digestive tract.

Definition.

Intestinal obstruction, in the broad sense of

the word, is any interference with the progression of the intestinal current. This conception includes interference with intestinal continuity from any cause and includes both mechanical and paralytic forms of obstruction.

Etiology.

Engel (48) divides the obstructions into two main classes. First and most frequent, those due to mechanical agents; second, those due to nervous mechanism upsets.

Mechanical agents, according to Wangensteen (152), are much more frequent than the nervous or paralytic upsets. Such mechanical agents due to stricture are: (1) narrowing of the lumen and narrowing of the bowel wall, obturation of the lumen by a foreign body, or compression from without, (2) adhesive bands, (3) hernia, (4) volvulus, (5) intussception, (6) congenital defects. Nervous mechanism upsets may be grouped into: (1) inhibition ileus (paralytic), and (2) spastic ileus (dynamic). Vascular interruptions from upsetting the normal blood flow may be divided into: (1) thrombosis and embolism of the mesenteric vessels, and (2) severance or injury of the mesenteric vessels due to operative or blunt trauma.

Wangensteen (152) states that strictures of the bowel wall may be either congenital or acquired. Congenital strictures may result from atresia of the large or small bowel or from an imperforate anus. The acquired strictures are of four types; inflammatory, traumatic, vascular, or neoplastic. He states that carcinoma of the sigmoid flexure is the most frequent cause of stricture of the bowel. Compression of the bowel from without is only likely to occur where the movements of the gut are limited as in the pelvis and the retroperitoneal duodenum.

Engel (46), in his discussion of adynamic ileus, states that adynamic ileus may be due to localizing diffuse periotnitis or may be of a non-septic nature and due to trauma, giving fluids too soon after operation, too much morphine, low serum proteins, or hypochloremia. Ochsner (112) observes that every surgical procedure is followed by a period of so-called physiologic ileus and that only when the condition becomes aggravated and distention progressive, may the term adynamic ileus be used.

According to Gillespie and Rogers (59), congenital obstruction of the small bowel is rare but important. The most frequent site of this is found in the duodenum; next it is found at the duodenal-

jejunal junction, and lastly at the location of the vitelline ducts. He lists the etiology of congenital obstruction: (1) Intrinsic obstruction with reference to the continuity of the small intestine due to an intraintestinal defect. (2) Extrinsic obstruction by external pressure due to faulty rotation. (3) Paralytic ileus is uncommon in the newborn, but when seen may be related either to peritonitis, tortion of an intra-abdominal tumor or organ, neurosis of the bowel from embolism, thrombosis, or to lesions of the spinal cord, or nerves supplying the bowel.

Pathology.

Wangensteen (152) states that in considering the pathology of intestinal obstruction there are essentially two types, simple or strangulated. He defines simple obstruction as that type of obstruction in which continuity of the bowel is maintained; while strangulation obstruction is obstruction in which there is an embarrassment of the blood supply which may result in either actual or threatened tissue death. In several articles (147, 152,153) he has advanced his table of co-ordination between the clinical and pathological classification of the various types of intestinal obstruction.

Clinical Class	Pathological	Treatment
A. Mechanical		
I. Narrowing of the lumen		
1. Stricture of the bowel wall		
a. Congenital Atresia Imperforate anus		
b. Acquired Inflammatory Traumatic Vascular Neoplastic	Simple--except in neoplastic stricture of colon	Operation, proceeded by suction for decompression in late cases, except in occlusion of the descending colon
2. Obturation		
3. Compression from without (especially in pelvis and retroperitoneal duodenum)		
II. Adhesive bands Congenital Inflammatory Traumatic Neoplastic	Simple or strangulated	Suction, operation for persistent obstruction and in strangulation
III. Hernia External Internal	Strangulated	Early operation
IV. Volvulus		
V. Intussusception		
B. Nervous		
I. Inhibition ileus (paralytic)	Simple	Suction
II. Spastic ileus (dynamic)		
C. Vascular		
I. Thrombosis of mesenteric vessels		
II. Severance or injury of mesenteric vessels (operative or blunt trauma)	Strangulation	Early operation

In simple obstruction, according to Wangensteen (153), the bowel wall above the obstruction is distended, and if the obstruction is acute in character, it is thinned out, while in chronic obstructions the wall is thicker, and there is a hypertrophy of the circular muscle. The length of the intestine is dependent upon the duration of the obstruction, and Mouks (103), in 1903, demonstrated that almost the entire length of the small intestine could be puckered or "gathered up on a one foot segment of a glass rod introduced into the intestinal lumen."

Ochsner (114) states that Dragstedt, Land, and Millet have shown considerable variation in the intramural blood supply to the various parts of the intestine, and owing to this anatomic variation, intraintestinal pressures exert varying influences on the blood supply.

Wangensteen (153) states that in acute obstructions the bowel is usually hyperemic and redder than usual. Ochsner (114) states that intra-intestinal pressure might interfere with circulation and cause gangrene of the bowel wall.

Van Zwalenburg (146) observed that distention of the gut (or of any other hollow viscera) inter-

feres with the circulation in its wall and allows infiltration and effusion to take place from the wall into the lumen. Gatch and Culbertson (58), studying the circulatory disturbances in intestinal obstruction, found that the blood flow through the intestinal wall decreased and that it ceased where the systolic blood pressure was equaled.

Wangensteen and Rea (159) state that the distention found in intestinal obstruction is due to accumulation of fluids and gas proximal to the obstruction, and the degree of distention depends on the degree of the obstruction. Orr (116) demonstrates how the fluid in distention accumulates.

He states that for every twenty-four hours the following fluids enter the intestinal tract: 1500 cc. of saliva, 2000-3000 cc. of gastric juice, 300-500 cc. of bile, 3000cc. of succus entericus, 500-800 cc. pancreatic juice. This total of about 7500 - 8000 cc. is secreted into the upper intestinal tract, and is entirely reabsorbed by the lower portions of the bowel with the exception of 100 cc. of fluid that it lost every twenty-four hours through the feces (Coller, Dick, Maddock, 23).

The amount of fluid secreted into the upper gastro-intestinal tract is two to three times the

amount of water injected by mouth and two times the volume of blood. Therefore in case of an obstruction of the small intestine it is easy to see the reason for the rapidity of distention.

The gases present in the distended loops of bowel have been shown by McIver, Benedict, and Cline (95) to be threefold in origin. The main source is from swallowed air, then decomposition of intestinal contents and thirdly, due to diffusion of gases from the blood stream into the lumen through the mucosa.

Wangensteen (151) studied the pressure present within the lumen of the bowel at the time of operation. While pressures of twenty to thirty centimeters of water have been observed in obstructions of the colon, he was only able to obtain pressures of ten to sixteen centimeters of water in cases of small bowel obstruction despite great distention. Morton (106), on the other hand, found the pressures to be higher. He observed pressures of twenty-eight to thirty-six centimeters in the duodenum, but only four to five centimeters in the ileum. These pressures, however, Wangensteen observes (155), are sufficient to decrease venous drainage and cause a hyperemia of the bowel wall. During a period of forty-eight hours

the bursting strength of the gut will be decreased, and often the distention will be great enough to result in rupture.

The signs of tissue death are nicely stated by Wangensteen (153). All of these signs may be observed in strangulation obstruction. The wall varies from a dusky cyanosis to a bluish-black discoloration. This is caused by infarctions in the wall due to the arrest of the return of the venous blood which is caused by the distention. The blood is pumped to the intestine under systolic pressure, but leaks in the veins occur, and there may be a considerable loss of blood. The lumen of the bowel may be filled with blood, and often there is a serosanguinous fluid in the peritoneal cavity. As has been stated before, when the pressure becomes great enough to endanger capillary circulation, there is an anemic infarct, gangrene, and perforation. Wangensteen (154) observes that the bowel wall is still viable if it returns to normal color and contractility on pinching it together or application of hot packs on it. Another method to tell viability is to determine the pulsations of the mesenteric vessels.

Physiologic Considerations.

There are three main physiologic considerations

with intestinal obstruction. These are loss of chlorides, dehydration, and toxemia.

Chloride loss and dehydration will be discussed at greater lengths in a subsequent chapter, but chlorides are lost through vomiting and from suction methods. It has been found by Van Beuren and Smith (144) that in 130 cases of acute ileus the major cause of better prognosis in the cases was due to a better chloride and fluid balance. It was originally thought that the chloride detoxified a toxin produced in the bowel, and that this toxin was produced in the intestinal tract. It has since been shown by Wangensteen (149) and Gatch (56) that there is an alteration in blood chemistry in acute obstruction. There is a decrease in blood chlorides, an increase in the carbon dioxide combining power of the blood. Wangensteen (149) states that sodium chloride is specific for the high obstruction, as it is an antidote for the vomited fluids, and death occurs within three to four days if nor used.

The toxic theory of causation of death has had a number of advocates. Kennedy and Hensen (81) state that there seems to be a toxin within the bowel absorbed into the blood stream causing the signs.

These toxins arise from several sources. They may originate from stagnating food in the intestinal tract, but they state that there is little evidence to support this theory as putrefaction of food rarely appears in high obstructions which have the most marked signs of toxemia. They cite Murphy and Brooks, who suggested that the toxin might be a result of bacterial invasion and suggested clostridium welchii as the causative organism.

A third theory of the toxin was suggested by Wilke (187). He made the observation that toxic products are not absorbed from the normal gut, and suggests that the intoxication is due to abnormal absorption of normal secretions. This has some basis due to the fact that saline is effective in high obstructions but is of little effect in low.

A fourth theory mentioned by Kennedy and Hansen (81) concerns the abnormal secretions of duodenal cells caused by distention and upset of the blood supply to the duodenum. Wangensteen and Loucks (156) have found that the toxin must be different from histamine for histamine could be detected in the blood stream two days after simple obstruction was accomplished. They found that autolysis of the intestinal mucosa from deprived blood supply is rapid

and this is accomplished by a toxic substance. They conclude, however, that the toxin is unlike histamine. In similar experiments, Gatch (56) injected potassium cyanide and nicotine into the distended loop with no effect as long as it was fully distended, but at a pressure of half systolic blood pressure there was a rapid absorption of the toxin. This is the basis of the modern suggestions of therapy that will be discussed later. There now comes the conception sponsored by Coller, Bartlet, Bingham, Maddock, and Pederson, in a series of articles, that fluid balance and dehydration are the cause of the intoxication. This will be discussed in a later chapter.

Symptoms.

The onset of intestinal obstruction is usually accompanied by pain, nausea, and vomiting (McGehee, 95). The pain is of the type of an intestinal colic and is of a crampy nature that may be described by the patient as a gas pain. This pain is usually not of long duration and is found at the height of the peristaltic rush. Frequently there may be a metalic tinkle heard through the stethoscope, and this is a sign of distention of the bowel. Wangensteen (154) states that the colicky cramps are caused by the resistance of the intestinal muscles to distention. That reflex vomiting

may occur in any acute abdominal disorder, but the significance of mechanical block is seen when the vomiting becomes intestinal in character (147). That the vomiting becomes frequent and is copious and is of a regurgitant character (152). The only case of obstruction of the bowel in which there is no vomitus, is in obstructions of the left colon, although the distention may be great. This is apparently due to the action of the ileo-colic spincter in spite of the observation of roentgenologists that this is not always competent. Wangensteen (151) counters this objection with the suggestion that perhaps the slow distention and lower pressure encountered by obstructive force might have a different effect on the valve than the relatively high pressure used in administering enemas. He (151) also suggests the rule that when the vomiting is stercoraceous or fecal in character, the obstruction is in the small intestine. Kennedy and Hansen (81) find that the patient has less severe pains in paralytic ileus and that there is no relation to peristalsis for the abdomen is silent.

Physical findings.

The physical findings of the patient in strangulated obstructions are distinctive. The patient early shows

no external evidence of the fact that the condition is serious. He has a slight increase of pulse rate, but respiration, temperature and blood pressure are usually normal. Later the findings become marked, and due to dehydration and blood chemistry changes in the temperature become elevated, the patient assumes an anxious expression, the pulse becomes rapid but feeble, thenthe skin becomes cold and clammy, and the patient is obviously gravely ill (Kennedy and Hensen, 81; Wangensteen, 147).

If seen early, the abdomen is only moderately distended and the findings vary with the type of obstruction. If it is a chronic obstruction there may be visible peristalsis due to hypertrophy of the circular muscle. In simple obstruction the course is not as rapid as in strangulated obstruction, and the abdominab wall may be relaxed between pains but becomes tense at the height of the pain. In strangulation obstructions a very important finding is the rebound tenderness. Kennedy and Hansen (81) state that this tenderness is due to peritoneal irritation and the muscle spasm is a direct result of the attempt of nature to splint the part. There may be a slight rebound tenderness in cases of simple

obstruction, but Kennedy states that it is rarely seen, and only in cases with great distention. Wangensteen (152) states that the distention is a cause of the tympany obtained by percussions.

Auscultatory findings are emphasized by Wangensteen (147, 148, 152, 153). He states that the stethoscope is important in determining the difference between the strangulated and simple type of obstruction. If there is a block in the intestinal continuity due to strangulation, the borgorygmus may be heard at the height of the colic. If there are no sounds heard, thenthe intestine may be assumed to be paralytic. If the intestine is under considerable tension, the sounds will have a metallic character. Intestinal colic may be differentiated by the lack of timing of sounds with the colic.

Laboratory Findings.

The roentgen findings are also important. Wangensteen (148) states that gas is normally present throughout the alimentary canal, but in the adult it is only visualized in the stomach and colon. This is because of the churning action of the peristaltic waves. When there is a stasis of the small bowel gas will be present. Complete obstruction can be determined by X-ray preceded by an enema in order to

remove gas in the colon. If there is no gas beyond the distended coils the obstruction is complete, but if gas does extend beyond, then the obstruction is incomplete. The gaseous distention has a characteristic appearance and was first interpreted by Case to be strong evidence of intestinal obstruction (Lofstrom and Noer, 90). These patterns are now called "ladder patterns" when the patient is upright. Wangensteen (148) advises the use of the supine position because of added information obtained. He states that it is possible to approximately locate the obstruction by the use of this method. He is careful to state that in order to agree upon the significance of roentgen findings the observer must assume that the chief source of gas is swallowed air and that the bowel beyond the obstruction is functionally, as well as anatomically, normal.

It must be remembered that the use of barium by mouth is a dangerous procedure, and Lofstrom and Noer (90) caution against its use, because of the danger of converting a partial obstruction into a complete one.

Dehydration is the chief cause of laboratory finding. There may be a leukocytosis, increase in erythrocytes and hemoglobin due to this dehydration.

The urine is scant, but the urinary function is not impaired, for the administration of saline or glucose in distilled water will correct the anuria (117). Wangensteen (152) states that the body chemistry is not altered early in obstruction and is of little value in diagnosis, but may be important in high obstructions due to chloride loss.

Diagnosis.

In review of the symptoms and findings Wangensteen (152) suggests the criteria for an early diagnosis. Intestinal colic which can be timed by ausculation, and by this method determination of the type of obstruction may be made. The roentgen examination will show gas in the small intestine, and the ladder pattern need not be waited for. The stethoscope is important in timing of the pain with the barborygnic if it is present. The general condition of the patient is good, early in the disorder, but if late, dehydration with scanty urine and increased specific gravity is found. The sensorium is usually clear up to the end. Leukocytosis, increase in hemoglobin, and increase in erytherocytes may be present due to dehydration.

When the obstruction is strangulated the patient is ill with an agonizing pain. He has a rapid pulse, with a temperature ranging from 100 to 101 degrees Fahrenheit. Often he is in shock. Peritoneal irri-

tation and rebound tenderness is a constant finding. Loud peristaltic waves and peristaltic reshes of the proximal bowel are characteristic. Reflex vomiting appears after the onset of the pain, and its continuance depends on the character of the obstruction. At times blood has been observed.

Factors Delaying Diagnosis.

Wangensteen (147) lists a very excellent set of warnings in his factors for delaying diagnosis. It must be remembered that there may be an absence of local physical findings. Often this absence gives one the impression that the process is not serious. He cautions one to remember that simple obstruction does not give rise to local physical signs, but there may be an intermittent crampy pain that should be seriously considered in spite of absence of local tenderness. He states that mistrust in enemas is another factor in obscuring the early diagnosis in obstruction. There seems to be a general tendency to disbelieve in the presence of a complete obstruction as long as feces is returned by an enema. It must be remembered that feces will be returned as long as there is any material in the distal loops. He states (147) that he has observed feces returned in experiments even though the bowel has been divided and closed. He

advises the soap suds enema and has a trained person observe the results. If there is an expulsion of gas and feces, but if pain continues, he advises another one, Noble's, twenty or thirty mintues later. If the pain continues, and if there are other signs, it is safe to assume that there is an intestinal obstruction.

Morphine, although a wonderful drug, is dangerous in early intestinal obstruction. Morphine decreases the colicky pain and thus lulls both the patient and physician into a false sense of security. Contrary to first thoughts, morphine increases the tone of the bowel and loud borborygmi are heard, not only over the unobstructed portion of the intestines, but also over the obstructed portions. Therefore, Wangensteen (147) states that morphine should never be given until a diagnosis is established.

The fourth caution stated by Wangensteen concerns the deception of apparent catharsis to the patient in intestinal obstruction. He finds that the expulsion of a stool after the administration of an oral cathartic does not necessarily mean that the bowel is obstructed. Pain after the passage of the stool, on the other hand, indicates that the obstruction is still present.

The differential diagnosis of the condition has

been discussed above under the diagnosis and also symptoms.

Prognosis.

The mortality of intestinal obstruction has been high although Van Beuren and Smith (143) have noted a drop in the mortality during the last twenty years. The mortality, at the Presbyterian Hospital of New York, during the period 1916-1919, was about 66.6 per cent, while in the period of 1932-1935 it was 28.4 per cent. They (144) attribute this fall of the mortality rate to four main changes in treatment; earlier operation, better understanding of the conditions, spinal anesthesia, and a greater replacement of fluids and electrolytes. In 1937, they (143) notices that the reduction was found mainly in the non-enterostomy group. Kennedy and Hansen (81) noticed, in their series, a drop of ten per cent since the advent of nasal suction. This fall, they attribute, to earlier calling of the surgeon, roentgen diagnosis, nasal suction and fluid balance.

Wangensteen (154) states that patients do not die from distention. Suction drainage of the duodenum has decompressed the intestine in cases with peritonitis yet patients still die. Elman (43) and several others (165,136,18) maintain that death is frequent following sudden removal of distention.

Dehydration is a common cause of death during intestinal obstruction, and much work has been done on the fluid balance and salt metabolism as applied to intestinal obstruction. One factor that Wangensteen is very careful to mention in all of his articles is that decompression should not be used as the treatment for strangulated obstruction. It may be used as a preparatory procedure for surgery, but should not be used alone as the treatment of the condition.

Treatment.

The relief of the obstruction is the ideal objective in the treatment of mechanical obstruction, but Wangensteen (153) states that this, at times, is unnecessary and even dangerous. During early mechanical obstruction the operation of choice is to find the obstruction and release the obstructing mechanism. In late cases of simple obstruction release of the obstructing mechanism may be accompanied by hazards and the best procedure is to first decompress the bowel and then to perform the operation releasing the obstruction. It is the purpose of this paper to discuss the decompression of the bowel; this will be discussed in a later chapter.

In general, what means do we have to combat intestinal obstruction? This is a condition which, with early correct diagnosis, the prognosis should be

favorable, but in cases with the incorrect diagnosis or with improper treatment a very grave situation will be developed, terminating unfavorably for the patient. The principles of treatment may be summarized from Orr's (116) Article. He states that the first principle is the relief of mechanical obstruction by operation. There should then be a maintenance of water balance through the use of saline and glucose. Decompression and relief of distention is a third principle to be followed. Heat should be applied to the abdomen. Oxygen therapy is of great value in certain cases. He finds that the bed posture of the patient is of importance. Lastly, blood transfusions have been known to favorably affect the prognosis and enable the patient to have sufficient protein and nourishment to turn the tide to a favorable outcome. Hay (72) states that if the obstruction is of short duration, operation should be performed at once, but if dehydration is present, preliminary preparation is permissable through decompression and intravenous use of fluids. He cautions against delay and procrastination in cases showing improvement.

There are essentially two types of operative procedure, the direct attack on the obstruction, and the enterostomy or indirect attack, or decom-

pression type. The choice between the operative procedures depends on viability of the bowel wall. If the color of the bowel returns, pulsations of the mesenteric vessels are observed, and it is early in the course of the obstruction, then the mechanical block should be freed(Wangensteen, 147). Later Wangensteen (152) stated that when late in the course of the disease and when there is no sanguinous fluid present in the abdominal cavity, one can be certain that the blood supply is not in danger, and then advises the suppression of curiosity and the performance of a "blind enterostomy" in order to decompress the loop of bowel first. He reasons that if there is an adhesive band causing the obstruction, it might be a tight cord extending from the lower lateral peritoneum, passing over the gut to the mesentery. If this were present for about four days there would surely be adhesions and a fusion to the gut wall through irritation. If the adhesions were severed between the gut and the peritoneal wall, the wall of the bowel might be torn, or there may be a small leak with resulting peritonitis. He urges therefore, that curiosity of the nature of the obstruction be suppressed and an enterostomy be performed. Then it would be possible to treat the obstruction at a later date.

If the gut is not viable, Morton (107) states that a resuction of the non-viable portion of the gut should be performed. Care should be taken in this procedure not to "strip" the gut, as Ochsner and Storch (114,138,139) have shown that this predisposes a toxic post-operative course.

Suction through the nasal cather and intestinal tube will be discussed later, but this method is important in the preparation of patients for operative manipulations. Orr (116) states that nasal catheter suction is much more effective in cases of paralytic ileus than enterostomy, and Holt (71) goes as far as to say that a too literal adoption of the old adage to "get the bowels open and the patients live", is more apt to kill than to save the patient. Orr's (116) rationale to give heat to the abdomen is to stimulate peristalsis and thus prevent an ileus.

Although it will be discussed later, the water and salt balanceis of great importance and should not be forgotten. The patient should receive fluid and salt pre-operatively, especially if dehydrated (Orr, 116). Ochsner, Gage, and Cutting (113) have shown that Hypertonic salt solutions have a stimulating effect on the motility of the intestine. Fine (50, 51, 52) and his associates have shown that oxygen

therapy is of great importance in supportive therapy in cases of obstruction. Orr (116) stresses a little thought of point in the treatment of intestinal obstruction. He states that the comfort of the patient as well as the vital capacity of the lungs will be increased if the back rest on the bed is elevated to place the patient in a semi-sitting posture. This may be altered at intervals to rest the patient. He also suggests frequent deep breathing and turning in order to prevent complications.

As the blood proteins are lowered in cases of strangulation obstruction, Orr (116) suggests that frequent small transfusions be carried on. Engel (46) states that there is a breakdown of aminoacids and protein in the blood stream. The repeated small transfusions will restore these back to normal.

Spinal anesthesia has been advocated by several, and Hay (72) states that its value is in increasing the tone of the gut and a relaxation of the spincters.

Drugs have been advocated by several in order to increase peristalsis and to force the release of the obstruction. Ochsner, Gage, and Cutting (113) suggest hypertonic saline solutions. Schlaepfer (133) suggests that paralyticatony of the intestine could be overcome with small doses of physostigmine. Elsom,

Glenn, and Drossner (45), working with a Miller Abbott tube, have found pitressin to cause a brief spasm of the duodenum, then followed by a complete relaxation fifteen to twenty mintues later. The jejunum will react to pitressin by increasing peristalsis, but decreasing tone, while the ileum increases its motor activity, increases its muscular activity, and discharges its contents at a greater rapidity.

Chapter IV

ENTEROSTOMY DECOMPRESSION

Introduction and Development of Enterostomy Methods.

Decompression, according to Johnson (76), is the oldest and most obvious form of treatment for intestinal obstruction. The oldest method, he states, was a blind puncture of the intestine by use of a trochar. This method offered the patient little, except peritonitis, and was never popular. Furthermore, he states, that for over a hundred years, enterostomy has been performed with a certain measure of success and in cases of simple acute obstruction, enterostomy was sufficient to relieve the obstruction, but in the majority of cases, left much to be desired because it did not attack the site of the trouble.

Treves (140) in his book on Intestinal Obstruction, revised in 1899, states that operation is dangerous, but that delay is worse. He felt the inadequacy of the method, and stated that primary enterostomy was at best a palliative operation, and not founded on sound surgical principles, for it is an operation performed in the dark, leaving the cause untouched. He states the prognosis expected at that time in cases of obstruction would be the same as the prognosis of a man jumping off London Bridge. Johnston (76) agrees

that Treves was correct for the most part, but that enterostomy does have its place in the treatment of intestinal obstruction by decompression.

The first decompression attempts, therefore, was by the operative efforts to introduce tubing into the intestine and thus decompress the entire intestinal tract. Colp (36) states that ileostomy was first used, but this was discarded. McKenna (97) writes that Bonney suggested, in 1909, that ileostomy should be discarded in favor of a jejunostomy. He listed a group of post-operative paralytic ileus cases treated by jejunostomy. The simplicity of the operation and the success in the cases which were treated by Bonney led to its universal adoption. It was thought to be useless to open the intestine just above the collapsed part, due to failure of drainage. Colp (36) says that theoretically the jejunostomy should lessen the absorption of toxins and drain the duodenum, but that this is theoretical. Hayden and Orr (118) found that in draining of otherwise normal dogs, their death would be caused in two to five days. They observed changes in the blood chemistry similar to that observed in high obstruction. They also observed the life of the dogs was increased through the injection of sodium chloride. Another

group of their animals, with drainage established just above the cecum, lived for a longer period.

Methods of Enterostomy.

Enterostomy is the present day procedure, although it is not new. Enterostomy was advised by Treves (140), who states that it is fortunate for the surgeon that the most distended coil of gut makes its way to the site of operation. Colp (36) and Wangensteen (149) advise the Witzel technic for the enterostomy. This consists of placing a number sixteen French scale catheter on the bowel and establishing an oblique tunnel by short continuous sutures or a few interrupted sutures before the intestine is entered. Wangensteen (52) cautions against the spillage of any intestinal contents and advises aspirtaion with a syring or milking the contents back with the fingers. After the enterostomy, Wangensteen (147) states that it is surprising to note how little drainage there is from the tube in the majority of instances, and suggests that the procedure establishes continuity of the still distended gut. He finds a large amount of fluid drainage only in cases of fairly complete obstruction. Even in cases of complete obstruction, after the first twenty-four hours, the fluid drainage decreases from 50 to 250 cubic centimeters.

Indications for Enterostomy.

Since the advent of the nasal catheter decompression, the indications for enterostomy have decreased. The operation as Hayden and Orr (118) have shown is in itself a serious step, unless it is followed by saline and other supportive therapy. Therefore, when Wangensteen (147) popularized the nasal catheter suction decompression, the enterostomy procedure became less popular and is now used only when indicated. Wangensteen (147 et seq), Erdman (49), Mensing (99), Morton (107), and Orr (115) have fairly well defined these indications.

Mensing (99) states that enterostomy is done only in the most imperative conditions now. The persistent post-operative mechanical obstruction failing to respond to medical management should be an indication for enterostomy. Morton (107) finds that the condition of the patient at the time of entry into the hospital is the most important factor in determining the type of operation, if any, that can be tolerated. In patients forty-eight hours beyond the onset of the obstruction and if the small bowel is greatly distended with foul contents that are stagnate and toxic, there may be no way to determine whether there is a strangulated loop present.

He finds that the temperature may be normal or sub-normal, the pulse slow, the patient restless, or drowsy, the vomitus may be beginning to have a fecal odor, and the white count out of proportion to the abdominal findings. In cases like these, he (Morton) advises not to underestimate the gravity of the situation, and when operation is done, not to do too much and suggests a preliminary enterostomy for decompression.

Wangensteen (153) advises the use of a "blind" enterostomy in late cases of obstruction with adhesive bands. He states that when there is no sanguinous fluid present in the abdomen the blood supply is not in danger, and that it is much better to suppress curiosity and perform a "blind" enterostomy rather than release an adhesion and cause a tearing in the bowel wall with subsequent spillage and peritonitis. Erdman (49) agrees with Wangensteen in that the greatest indication for enterostomy is in cases of mechanical obstruction. He continues that it is seldom indicated before the sixth or seventh day post-operatively. Orr (115) finds it important as an adjunct to exploration and release of simple intestinal obstruction. He also finds it an important procedure associated with resection of the bowel in

volvulus or strangulation. A third indication advanced by Orr is as an accessory procedure in intussusception.

Contra-Indications and Failure.

All of the above authorities agree that enterostomy has no place in paralytic ileus. Golp (36) states that the mortality in the adynamic type was about eighty per cent. This has been decreased by nasal suction, therefore the procedure should be discarded in cases of ileus.

Failure of the enterostomy to decompress, according to Mensing (99), is due to several factors. The overdistended bowel may not regain its motility and tone, therefore it is not capable of passing the fluid and gas to the site of the decompression. There may be a paralytic ileus caused by peritonitis which in turn may be caused by the enterostomy soiling the peritoneal cavity. The Weitzel technic has been advanced in an attempt to prevent this, but there may be, and usually is, some spillage during or after the operation. Should the enterostomy be imperfectly accomplished, a mechanical obstruction may result and may even end in strangulation.

Wangensteen (150) states that the action of the distended loops of bowel, frequently cause a failure

in decompression, When one loop of the bowel becomes decompressed and the distended loops become kinked and so hinder drainage. Thus, he states, enterostomy often fails because of the very mechanism it is trying to relieve.

Intoxication as Related to Enterostomy.

One of the most debated points in the field of intestinal obstruction is the presence or absence of toxins. Elman (43) finds that following successful relief of a simple mechanical obstruction such as cutting an adhesion or the employment of an enterostomy, the patient became worse within a few hours and died. Elman (43) cites Schede (131) who in 1887 recorded the case of a boy eighteen years old who was operated upon on the eighth day after the onset of symptoms. A ligamentous band in the mid-ileum was cut and the dilated bowel emptied. The boy died with increasing "cardiac weakness" twenty hours after the operation. Murphy (108) observed a patient die with toxic symptoms nine hours after relief of the obstruction. This led Elman and others to look for a toxin in the intestine. They conclude that the usual cause of death is from the absorption of toxic products. Van Beuren (142) finds the intentinal contents as toxic before operation

as well as after the obstruction is relieved. Britton (18) finds that the patients die following enterostomy as well as from the direct relief of the obstruction. Wilke (187) showed that toxic products are not absorbed from a normal gut. Death follows the relief of distention in late low obstruction. He advanced the explanation that intestinal capillaries are paralysed and dilated allowing blood to enter the splanchnic area. Therefore there is a decrease of available blood to the systemic circulation, and thus saline and glucose injections are of value in the toxic symptoms.

Murphy and Brooks (188) took the "toxic contents" from a seventy-two hour obstructed dog and injected it into another dog which vomited but did not die. Stone (136) suggested that the relief of obstruction and evacuation of the bowel contents hastens a general dissemination of toxins in the bowel wall. The relief of distention and a fall in the intra-intestinal pressure permits a rapid return of circulation through the tissues of the bowel wall, thus permitting the revived circulation to rapidly carry off the poisonous substances. This was the first step in the development of the theory of intoxication following rapid decompression.

Wheeler (164, 165) noticed that acute cases with rapid relief of distention had symptoms of intoxication, but when decompression was slow the toxic symptoms did not appear.

Morton (106) and Ochsner (138, 139) found that "stripping" the bowel wall had a deleterious effect and that death from an apparent intoxication resulted. The fever became septic in character and often went up to about 108 degrees. They urged abandonment of the process of "stripping" the bowel in enterostomy. Elman (43) cites the finding of Lowers (91), that there is a decrease in blood pressure after "stripping" the bowel wall, especially after the obstruction is several days in duration. This finding has been verified by Storck and Ochsner (138).

Gatch (56), in an attempt to determine the mechanics of the advanced intestinal obstruction and the dangers of a too sudden relief of the intra-intestinal pressure above the obstruction, injected potassium cyanide into a distended loop of bowel with no results, but where the pressure was decreased to one-half of systolic blood pressure, there was a rapid absorption of the toxins. Wangensteen and Loucks (156) did similar experiments with histamine

under the assumption that it would be liberated by degererative processes in the bowel wall. They were unable to find any evidence of absorption of the substance.

Elman (43), in presenting his theory, suggests the following observations on which to found his explanation of the toxic symptoms. He has found that successful relief of late occlusion is frequently found to be followed by death. This apparently is connected with a decrease in the intra-intestinal pressure. The immediate recovery of the patient is good, the operation is short, there is no loss of blood. The clinical picture is one of profound infection with restlessness, delerium, a fast bounding pulse, and high fever.

Elman (43), taking the above observations, tried to explain the cases with intoxication symptoms. He states that the circulatory changes in the wall rapidly become marked in distention of the bowel, There may be a resulting localized gangrene. Edema is present if there is no gangrene, and the swelling is a site for necrosis and loss of mucosa. Normally, the mucosa is a barrier against poisons present in the intestinal tract due to the selective action of the intestinal epithelium, but whenedamaged or necrotic,

this selective power is lost, and therefore poisons may enter.

If the pressure is high enough to keep down the blood flow through the gut wall, there would still be a barrier before they reached the liver and blood stream. When there is a rapid decrease in the intestinal pressure, due to rapid decompression, through enterostomy, enterostomy and stripping, or mechanical relief of the obstructions, he suggests that there is an inflow of blood and an overwhelming toxemia that is so great the liver is unable to handle it.

He (Elman, 43) suggests abandonment of "stripping" with enterostomy and the gradual deflation of the distended bowel to allow the readjustment of circulation and absorption to take place slowly.

Van Zwalenburg (146) states that although many patients die of dehydration, there is a hydraulic vicious circle developing in the intestine causing a necrosis of the bowel wall, and Gatch (57) finds that dehydration is the chief cause of death, but there may be an indication for the slow decompression of the distention of the gut.

Chapter V

GASTRODUODENAL DECOMPRESSION

Introduction.

The treatment of intestinal obstruction was entirely surgical up to about 1930. Siphonage was at this time in vogue, despite the fact that Ward (161, 162, 163), in 1925, and again in 1929 and 1930, suggested suction decompression for use in intestinal obstruction. Cutler (30) states that Wangensteen deserves major credit for the development and popularization of the method. It was directly due to Wangensteen and his numerous articles, that tremendous interest has been taken in this field of therapy, and the numerous developments that have been made since 1933.

What Decompression Attempts To Do.

Mensing (99) summarizes the advantages of decompression therapy. He states that there is an improvement in splanchnic circulation and an increase of circulating blood volume. There is a restoration of intestinal tone and motility, providing distention has not been to such a degree that recovery is not possible. There will be, after decompression, an acceleration of the absorption of gases in the intestinal tract as well as an absorption of the fluids.

There will be, following suction, a decrease in the "paralytic secretion" of the intestinal juices and lastly the edema and spasm at the site of the obstruction will be decreased in amount.

Wangensteen (150) states that nasal suction methods are successful in nine out of ten patients, but (160) the practice of employing suction as a test procedure to indicate whether or not operation will be necessary, leads only to deferment of the appropriate treatment. Neglect of the indications and contra-indications is one of the serious errors one may fall into with the employment of nasal suction.

He states (160) that suction drainage is a "blind method", far more dim than "blind enterostomy" where the abdomen is at least opened. He states that it is important in the use of the method, that one should be acquainted with the short-comings and limitations of the method as well as with its advantages.

He continues to the effect that with a knowledge of the significance of intestinal colic, the absence or presence of peritoneal tenderness, the character of gastric aspirations, and with the disclosures of the scout films of the abdomen, one can tell whether or not obstruction is present, whether it is simple or strangulated, where the obstruction is approximately

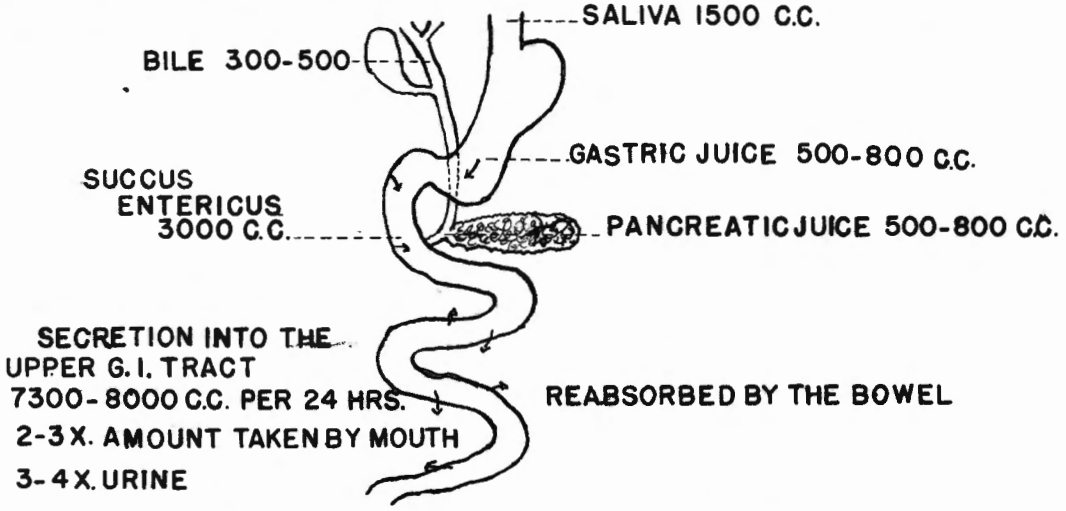
located, and whether it is complete or incomplete. One cannot, with the above findings, often tell what the causative agent or the mechanism of the obstruction is. The determination of the pathological mechanism without operation is impossible or a matter of conjecture.

Paine (122) states that there are two main purposes for the use of the duodenal decompression. The first of these is to remove, as far as possible, the gaseous and fluid contents of the digestive tract which are impossible to be transported and disposed of in a normal manner. The second is to prevent, as far as possible, any further accumulation of gases and fluids in an already distended digestive tract.

Baker (11) states that the distention found in intestinal obstruction is caused by gas and fluid. The fluid is from the digestive juices poured into the gut from the higher levels of the alimentary tract. McIver et. al. (96) have shown that the greater part of the gas present in distention is swallowed air. Baker (11) states that if these two facts are correct, the rationale for the duodenal tube is correct and should be of great benefit in intestinal obstruction. Paine (122) states that the duodenal

decompression does achieve the purpose for which it is used if certain physiological facts are remembered. Wangensteen (152) states that any method, such as gastro-duodenal aspiration, which removes swallowed air as rapidly as it gains entrance into the stomach, will effectively prevent, to a great degree, any increase in distention.

As has been stated above, fluids pour into the stomach and duodenum, and Orr (116), as well as Coller and Maddock (25), have shown that the digestive glands pour from seven to eight liters of fluid into the upper intestinal tract every day. As Orr (116) demonstrates in his diagram - the fluid is normally



transported downward in the intestinal tract to be reabsorbed at a lower level. When there is a block in the intestine there is a rapid distention and large quantities of fluid are found present when there

is no vomiting.

Wangensteen and Paine (158) state that if the intestinal tract were a straight tube suction would evacuate all of its contents. They tried this on cadavers and found that it was possible to decompress the entire length of the intestinal tract. When they tried this decompression of the intestinal tract of dogs, however, they found that the elastic coils and acute angulations hindered this decompression, were it not for the fact that a considerable pressure was present. They observed that on decompression either the entire length could be decompressed at once, or that alternate loops of gas and fluid were present, resulting in a very slow decompression.

Paine and Wangensteen (124) explain that the elastic force of the intestinal walls equalize the intra luminal pressure throughout its whole length, and increments of gas and fluid are forced in to any region of decreased pressure such as surrounding the end of the tube. This accounts for the equal decompression of the whole tract at once. The action of the distended loops of bowel cause a failure of decompression. The distended bowel might kink on itself following decompression, and

there will be a failure to establish a drainage due to the pressure maintaining the kink.

Paine (122) finds that another factor aiding decompression is the presence, in many instances, of reverse peristalsis which carries gas and fluid from the lower portions of the intestinal tract up to the area of effective decompression. Knoepp and Phillips (84), on the other hand, find that with marked distention an irreparable damage to the bowel might occur, and that the gut might lose its ability to contract.

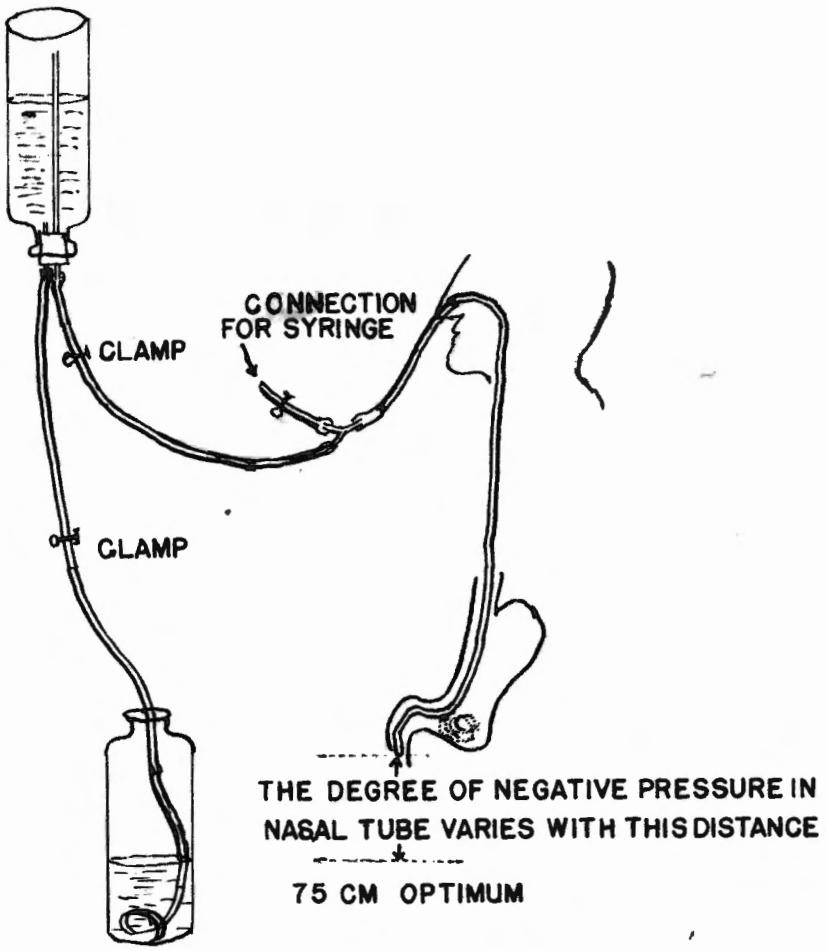
Methods of Gastro-Duodenal Decompression - Technic.

Wangensteen's (147) original method of continuous suction is still used at the present time. It consists of a catheter of the Levin type, size fourteen or sixteen, French scale, introduced through the nares. This is extended down into the stomach and duodenum. The proximal end was fastened to a two bottle suction apparatus which was the source of the constant suction. (See a diagram of this apparatus on page 63).

Many modifications of the original apparatus have been described. Little, Ramsey, and Pilcher (88) suggested a water pump with a mercury outlet valve attached, but this has not been accepted.

Carmichael and Guffy (21) suggested a method with a third bottle and re-enforced siphonage. The third

Diagram of Apparatus of Wangensteen (147)



Bottle has been adopted in many places as a method of measuring the amount of fluid material aspirated.

Hegge (66) has proposed a modified portable apparatus on wheels that is able to be conveniently moved from one room to another. Wangensteen and Paine themselves (123) have punched holes in the tube as far back as ten inches in order to facilitate drainage of the stomach as well as of the intestine. They state (157) that they have found best results with a negative pressure of seventy-five centimeters of water and find (158) that the degree of suction utilized by the tube is dependent upon the engagement of the wall of the intestine by the tube and the size of holes in the catheter. They have found that seventy-five centimeters water head seems to be in the optimatum range. Baker (11) finds that, if there is more than two and a half feet or more than seventy-five centimeters water head, the holes of the distal end engages the mucous membrane of the gut and defeats the purpose of the suction. Wangensteen and Paine (157) suggest turning the patient since this procedure will shift the heavy coils of the distended loops of bowel and will help in the decompression.

Knoepp and Phillips (84) find that, if the tip of the tube remains in the stomach, the aspiration of the duodenal contents is doubtful. It is true that considerable quantities of gas and fluid may

be regurgitated into the stomach, and this will be removed, but Paine (132) states that this cannot be relied upon. He suggests that in any case where there is considerable distention, an effort should be made to introduce the tip of the catheter beyond the pyloric spincter.

No ideal method has yet been divised to accomplish this purpose. Lippman (89) studied the methods of the insertion of the tip of the tube into the duodenum, used up to the time of 1914, and suggested a mechanism for the insertion of the tube. Morgenstern (104), in 1931, suggested fluoroscopic management of the tube. Wangensteen, Rea, Smith, and Schwyzer (160) have found that the catheter should be placed in the stomach and the patient moved in various positions until it is reasonably sure that the stomach is evacuated. They advise temporarily shutting off the source of the suction, and after drinking a glass of water the patient is placed in a lateral decubitus position with the right side down. The tube is advanced one inch every five minutes. At the end of thirty minutes, the cut-off is released, and Wangensteen states that if the obstruction is not great enough to divert the course of the tube, bile will be aspirated. They advise fluoroscopy to observe the location of the tube. Wangensteen and Paine (158)

suggest the inhalation of amyl nitrite if the pylorus will not relax. They also suggest that the use of a Levin tube with a weighted tip is satisfactory and has been observed to work is cases where it is impossible to enter the duodenum by the simple levine tube. Paine (120) states that painstaking care and patience will usually result in success.

It is important to measure the amount of material aspirated, in order to maintain the fluid and chemical balance of the organism, yet this is frequently neglected in the use of suction intubation. Wangensteen and Paine (157) record the technic for their two bottle method of decompression. The water running from the top bottle causes a vacuum in it, which in turn is transmitted through the long glass tube to the catheter ending in the duodenum. In order to determine the amount of fluid and gas aspirated, the volume of water in the upper and lower bottles at the beginning of decompression should be known. The amount of gas aspirated is measured by either having the top bottle graduated and reading the amount of gas directly, or by measuring the difference in volumes at the start and end of the suction period. If the volume in the bottom bottle was 400 cubic centimeters at the start of the period, the volume at the end of

the period would be equal to the 400 cubic centimeters, plus the volume of gas aspirated, plus the volume of fluid aspirated. Subtraction will give the volume of fluid obtained.

In using the three bottle apparatus, in which the third bottle is a trap to collect the fluid, the volumes may be measured directly.

Indications.

The indications for aspiration via the nasal catheter method are fairly well defined. Much has been written about the use of aspiration in intestinal obstruction, and Paine (122) states that, when properly used, the patient is greatly benefitted, and in many cases the necessity for operation is obviated. Wangensteen and Paine (158) find it indicated in all of those conditions in which suction alone will cure and also in those conditions in which there is a partial or acute obstruction. Wangensteen (152) has listed a therapeutic chart combined with clinical classification and a pathologic classification. This has been reproduced earlier in this paper, on page 24.

Wangensteen, Rea, Smith, and Schwyzer divide the use of suction decompression into three groups. First, there is the group of conditions in which suction alone is used. The second group consists of

those conditions in which suction decompression precedes operation and may be used during or after the operative manipulations. The third is a miscellaneous group of conditions in which the method is used.

Wnagensteen and Paine (158) assert that partial or simple mechanical obstruction can be adequately controlled and frequently released entirely, following decompression, unless the obstruction is due to a lesion in the intestinal wall such as a tumor or stricture. In these cases, if the obstruction persists despite aspiration, it will have been useful in the preparation of the patient for operation. As has been stated before, it is necessary to have the tip of the tube in the duodenum before an effective decompression is accomplished. Paine (122) states that many cases in his experience were slow to decompress until the duodenum was intubated.

Jones (74), and many others, state that the Wangensteen method is very useful as a decompression method in the pre-operative care of the surgical treatment of acute and chronic obstruction. The bowel, if decompressed, will be much easier to handle during operation, and will often change an unfavorable prognosis into a favorable one. Mensing (99) finds that, as a preliminary measure before operation,

nasal suction relieves the distention so that the operation becomes safer. He also finds that if aspiration is continued throughout the operative procedure, pulmonary aspiration and distressing pulmonary complications are avoided. Wangensteen and Paine (157) state that paralytic ileus, following operative interference in the abdomen, is the most frequent indication in which the duodenal decompression is used. Paine (121) states that inhibitive ileus from other causes are equally well treated by this method. Ochsner (113) states that, although duodenal decompression is fine for post-operative paralytic ileus, every operative procedure is followed by a period of so-called physiologic ileus. This may be prevented to a great degree by an avoidance of trauma, maintainance of a fluid and chemical balcane, and by a well maintained anesthesia.

Paine, Carlson, and Wangensteen (123) found the nasal catheter suction siphonage useful in post-operative cases for the control of nausea, vomiting, and physiologic ileus. They found, as McIver has shown (96), that much of the post-operative distress comes from swallowed air. Therefore, the use of continuous aspiration is of great benefit in the prevention. Engle (47) states that enterostomy is of

no use for distention, but at the first sign of nausea after operation, a Jutte of Levin tube should be inserted, which may often be removed in twelve to twenty-four hours. He also advises against the use of orange juice post-operatively, as this seems to cause severe post-operative distention.

Levin and Shushan (86) state that whenever upper abdominal distention develops fromwhatever cause, pre or post-operatively, the Levin or Jutte tube should be used. Paine (123) finds that for the past seven years of experience, at the University of Minnesota Hospital, after treating all patients subjected to major abdominal surgery with aspiration, he cannot recall of a single instance when it was necessary to employ a large stomach tube for gastric lavage after operation. He thinks that is is, therefore, much easier to prevent distention than to correct it, and that one should always anticipate its occurrence. Wangensteen and Paine (157) have also noted that post-operative nausea and vomiting is also decreased through the use of decompression. Paine (123) also states that decompression gives the best assurance possible against harmful tension on suture lines where it has been necessary to resect or anastomose the bowel or stomach.

Mensing (99) states that decompression by duodenal catheter is often an effective treatment in peritonitis. This is partly because of the rest that gastro-duodenal aspiration given the viscera. Paine (123) states that the routine use of this procedure in ruptured viscera enabled the postponement of surgery until the acute phase is passed, and by this procedure there has been a material reduction in mortality.

Contraindications.

In every one of Wangensteen's articles, and in many others, it is stressed that strangulated obstructions should not be treated by decompression. This brings up the differential diagnosis between a strangulated and simple mechanical obstruction. This has been discussed previously, but a resumé is in order at this time. Baker (11) summarizes the findings. The patient with strangulated obstruction looks sicker than the one with a simple obstruction; there are signs of shock present. The abdomen is more apt to be tense due to the exudation into the peritoneal cavity and the resulting peritonitis. This will cause an irritation of the peritoneum and rebound tenderness. The leukocyte count is apt to be increased out of proportion to the abdominal

findings. Wangensteen (147) is careful to state that in the borderline cases, where diagnosis of strangulation is doubtful, the abdomen should be opened, and he states at a later date, that if in opening the abdomen, and the presence of a sanguinous fluid is observed, there is a strangulation of the gut, and a resection is indicated. If not, curiosity should be stemmed, and an enterostomy should be performed (153).

Wangensteen, Rea, Smith, and Schwyzer (160) state that occasionally a simple obstruction will weep and cause abdominal tenderness. They advise operation as soon as the tenderness supervises and they predict that there will be a strangulation in the vast majority of the cases. They find that the only excuse for conservative treatment in acute small bowel obstructions with tenderness is in those cases in which there are repeated obstructions in the same patient, and that this is permissable only in preparation for enterolysis in an unobstructive phase.

Wangensteen and Paine (158) find the other absolute contra-indication is in obstruction of the descending colon. This is because of the fact that it is impossible to decompress the bowel at that level. Absence of vomiting may be a diagnostic sign in this

level, as it rarely, if ever, occurs, and if it should occur it would be found late in the course of the condition. Wangensteen (153) states that the ileocecal valve acts as a check valve, and permits the fluid to go into the large bowel, but rarely permits it to regurgitate back. Distention is often enormous in these cases and surgery in indicated.

Relative contraindications for decompression, listed by Wangensteen and Paine (158), consist of two groups. Strictures of the intestine are contraindicated at times, for the main attack should consist of a surgical attack on the obstructing mechanism. However suction is useful in preparation of the patient. Complete adhesive bands obstructing the lower part of the small intestine often make it necessary to resort to surgery in place of duodenal decompression.

Supportive Treatment.

What demands are made in the adequate management of a case with intestinal decompression? Wangensteen, Rea, Smith, and Schwyzer (16) have observed that there should be "scout" films of the abdomen in order to check up on the condition of the patient. They state that these are important because if the increments of swallowed air and fluid dumped into

the intestinal tract are withdrawn, without any decrease in the pain because there is no increase in the distention. Therefore "scout" films are necessary and should be repeated every twelve hours, and every four to six hours in critical times.

The above authors (160) advise against the use of narcotics, but tolerate the use of hot moist packs to the abdomen. Morphine increases peristalsis and relaxes spincters, but often obscures signs and lulls both the patient and the physician into a false sense of security. The fluid balance should be maintained and papaoral administration of saline to replace lost fluids is important. This will be discussed in a later chapter. Wangensteen et. al. (160) state that the treatment should be passive as far as the patient is concerned, and that drugs used to stimulate and increase peristalsis are out of place in the treatment.

Indications for Discontinuence.

Paine (122) finds that, although it is difficult to determine just when aspiration should be stopped, usually there is no difficulty encountered. He finds that three to five days aspiration is usually sufficient in cases in which duodenal aspiration is used to control post-operative nausea and vomiting. By this time

the peristalsis of the bowel has returned to normal, and the patient has begun to pass flatus. Wangensteen and Paine (158) state that the appearance of gas in the colon in complete obstruction indicates a satisfactory decompression and automatic establishment of the bowel. They advise clamping the tube from five to six hours before removing it. If, during this time, the patient does not become nauseated or distended, it can be assumed that the tube can be safely removed. If necessary, the aspiration may be continued for many days and the absolute limit is set only by the nutritional requirements of the patient.

Complications.

Mensing (99) finds one complication of the duodenal aspiration is its failure to accomplish a decompression. The common causes of failure are plugging, curling up in the cardia, and multiple gas traps in the intestine. All of these factors may be eliminated if care is taken and the details of the procedure are observed. Wangensteen (147) advises irrigation of the tube and tidal irrigations are also an excellent procedure. Paine (122) states that complications due to aspiration should be exceedingly rare. Two patients have come to his observation in which there was an ulceration of the mucosa in the

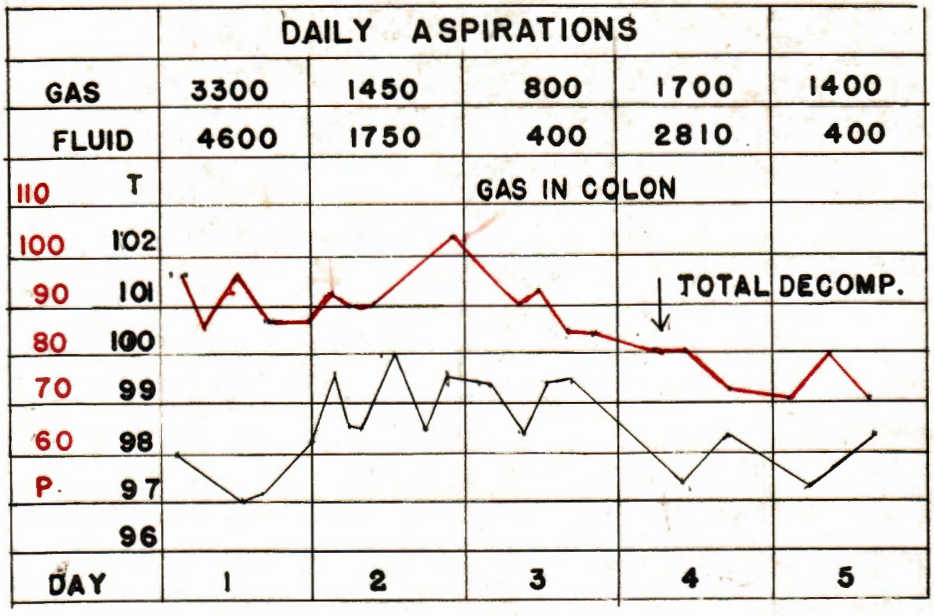
region of the arytenoid cartilages. One of the two had an abscess form which resolved quickly after incision and drainage. In the other a tracheotomy was necessary. He (Paine) states that minute ulcerations of the gastric and duodenal mucosa occur at times, and have been observed at the autopsy table several times, but at no time has he observed serious consequences from such an ulceration.

Paine(132) warns against the nasal catheter in small children and infants. He states that these patients frequently develop infections of the middle ear following nasal suction. Many of these infections seem to be directly due to an indwelling tube inserted throughout the nose. He explains this by the statement that the more horizontal and shorter Eustachian tube, which is present before puberty, probably is the mechanical factor for the infections, and suggests the tube be placed in the mouth and removed as soon as possible.

Wangensteen (153) observes the reaction accompanying conservative decompression. Before the decompression the patient, in the case of simple adhesive obstruction, shows no change as long as the gut is viable. The patient is kept in this condition in the cases of high obstruction, and the bowel wall is kept viable

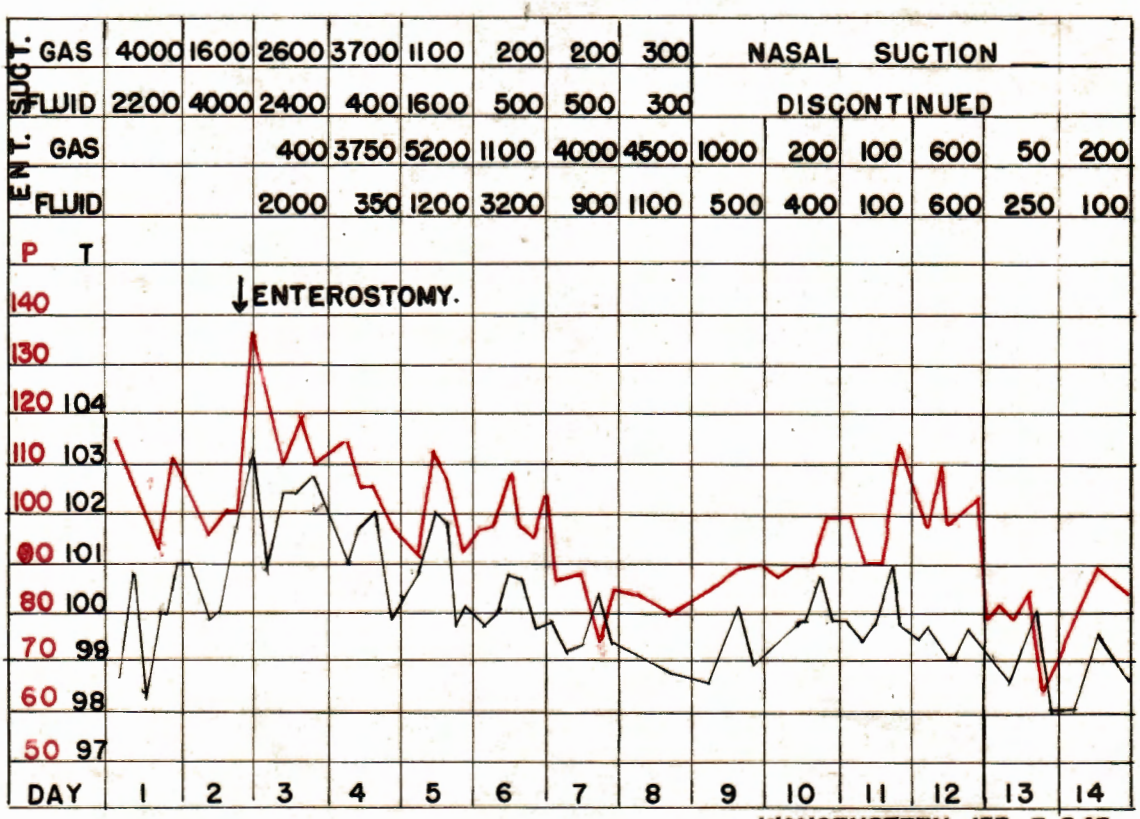
despite the presence of considerable distention. There may be no evidence of abnormal distention, and this fact suggests the possibility of a transperitoneal absorption through a bowel whose viability is impaired as a possible mechanism of the toxic action.

Wangensteen has found that the amount of fluid and gas aspirated by suction, as indicated by his graphs, correlates with the grade of obstruction. If there is a continued return of a large amount of fluid and gas, one may assume a high degree of obstruction, and one should have a "scout" film to determine the amount of distention present. The film, coordinated with the clinical findings, gives reliable information on the state of the obstruction; and then a survey of the condition at that time will enable one to decide whether to operate or to continue suction.



—WANGENSTEEN 153. P. 242 —

DAILY ASPIRATIONS



—WANGENSTEEN 153 P. 243.

Chapter VI

INTESTINAL DECOMPRESSION

Introduction.

Cutler (30) states that a well recognized limitation in the gastroduedenal method of aspiration is the failure to drain the lower portions of the small bowel. It was to this end that, in 1934, Miller and Abbott, working in conjunction, developed their method of intestinal intubation.

Miller and Abbott (101) state that they conceived their idea of intestinal intubation from the here-to-fore ignored jointed tube of Einhorn. Einhorn (33) suggested this tube about 1913, but it was never popular. Miller and Abbott (101) first attempted the use of the tube, but found it impracticable, because of failure to get beyond the duodenum and upper jejunum, because of the time involved in the passage of the tube, and because of the small lumen. They decided, therefore, that although the tube was satisfactory for the instillation of fluids into the intestine, it would never be practical in suction decompression of the small bowel.

Description of the Tube.

Miller and Abbott (101) devised a tube they thought

to be practical in the decompression of the intestine. This consisted of a long tube with a collapsable rubber bag at the distal end. There were two lumina passing through the tube, one for inflation of the bag, the other for the extraction and injection of materials. The first tubes that they devised, followed the pattern of Jones and Pierce (78), and had one tube within the other, but they found that the lumens were too small for aspiration.

After mechanical difficulties, Miller and Abbott (101) developed a tube about the size of an eighteen French scale catheter with two equal sized lumina. The walls of the tube, as well as the partition, measured one millimeter in thickness. Thus the tube, was fairly flexible, yet did not kink or curl on introduction. In general, this tube is the same as the present day apparatus. One important difference has been made, however, in the development of one lumen larger than the other. The larger lumen is intended for aspiration and the smaller for inflation of the balloon.

Johnston (75) finds that two tubes, one, a size eighteen Jutte tube, and a small-lumened tube for the balloon, are the best for intubation of the duodenum. Willson (168) thinks that the use of three

Saweyer tubes fastened with three-fourths inch cannulae are the best material to use for these tubes. They are flexible yet enable the easy entrance into the duodenum.

Technic of Use of the Miller-Abbott Tube.

Before insertion it is important to see that the balloon, tube, and connections are tested for air leaks. The balloon is also measured for the amount of air that it contains, as the amount varies from tube to tube. Klein (82) finds it important to examine the turbinates and septum for the best side to pass the tube. The balloon is then completely deflated and lubricated, and then may be inserted in the nare chosen. If desired, Klein states, the turbinates may be cocanized in order to make the passage painless.

The tube is passed to the stomach, and then the patient is placed on his right side and the attempt is made to pass the pylorus. This is the critical point of the procedure and the place that the method is apt to fail. Klein (82) states that one must not forget that there is retrograde flow into the stomach and that bile is often present in the stomach.

There have been several procedures advanced

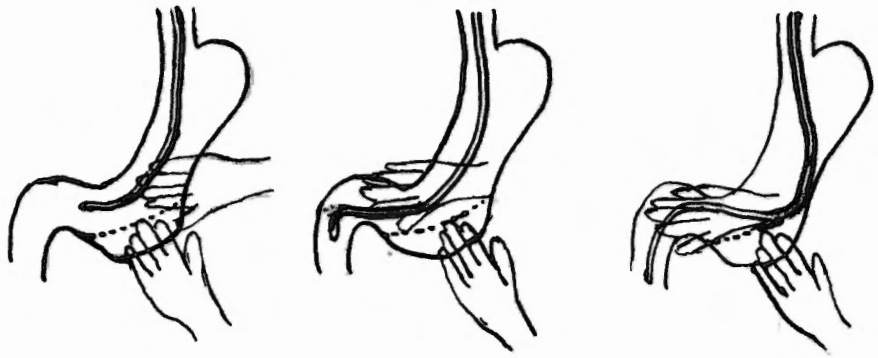
in the passage of the pylorus. Lippman (89), in 1914, made a study of the technics of putting the tip of the tube into the duodenum and suggested the following procedure. He first put the patient in a chair and a freshly oiled tube was passed into a fasting stomach to a depth of forty-five centimeters. The patient was then asked to bend forward for a minute and then was placed in a reclining position on the right side while the tube was injected twenty-five centimeters more. This position was maintained for about five minutes, and then the patient was placed on his back and in a full reclining position with the hips slightly elevated. Five minutes later the tube was injected ten centimeters more, which was supposed to have placed it in the duodenum. He stated that the whole method would take about fifteen to thirty minutes.

Morgenstern (104) suggested a method in 1931 for the introduction of the tube into the duodenum. The patient is taken into the fluoroscopic room and the tube is passed to the stomach while seated. The patient is then placed behind a fluoroscope and asked to relax. When the tube is in the middle stomach, the operator's left hand is pressed against the abdomen in the region of the greature curvature

of the stomach in order to raise it to the level of the pyloric spincter. (See diagram below, a, b, c.). The tube is slowly swallowed by the patient and guided toward the pyloric canal by the operator's right hand. (See diagram below, d, e, f.). It is gradually massaged into the first portion of the duodenum and introduced approximately one to two inches past the spinal column. The tube is then held in this position and more is swallowed forming a loop in the stomach. Then the patient's left hand is substituted for the operator's left hand to keep the greater curvature on the level of the pylorus, and then the patient is turned to the right side with aspiration. Morgenstern states that the loop formed aids in keeping the tube in place and enables its further passage into the duodenum. He reports successes in thirty-seven out of forty cases.

A B C

— MORGENSTERN 104 —



D E F

— MORGENSTERN 104 —

Miller and Abbott (102) in their original work used the above technic of Morgenstern in order to enter the duodenum with about an eighty per cent success. They found that by using this technic the tube may be 120-150 centimeters beyond the pylorus in six hours.

Abbott and Johnston (3), when they suggested the use of the tube for intestinal obstruction, stated that one of three technics could be employed. First of these was Morgenstern's method. The second was to empty the stomach, and with the patient lying on the right side thus allow the tip to sink to the pylorus, and to very slowly introduce the tube a few centimeters at a time. The third method they employed was to have the stomach moderately filled

and have the patient lie on the left side and float the tip into the pylorus.

Klein (82) states that at Mount Siani Hospital the tube is slowly passed to the lower portion of the stomach with the patient lying far on the right side and suggests the use of a heavier tip in order to have gravity play a more important part in the intubation. Morton (105) suggests that when the tip of the tube is at the pylorus, as seen under fluoroscope, the patient should be kept on the right side and with the suction running, and some slack in the tube similar to that advised by Morgenstern, with a completely deflated balloon, permit the stomach to carry the tip to the pylorus.

Johnston (75) has good results in the passage of the pylorus by employing a Twiss tip. This is a longer tip than usual, and seems to prevent kinking. He (76) reports that he was able to intubate the duodenum within six hours in 494 cases out of a series of 500 by the use of this tip.

Wangensteen and Paine (158) have suggested the inhalation of amyl nitrite if the pylorus will not relax.

The determination of the location of the tube and the moment it enters the duodenum is important,

for much valuable time may be lost if the tube is already in the duodenum. Fluoroscopic examination or scout films are the most positive methods of determination, according to Klein (82) and Wise (169). They state that in cases in which frequent following by X-ray is not practical, that one-half tumbler full of methylene blue could be given per mouth, and if the tip is in the stomach, the suction would immediately return it. If the return is not immediate, then it may be assumed that the tube has entered the duodenum. Wise (169) suggests a syringe test in order to determine whether or not the tube is in the duodenum. An empty glass syringe, thoroughly dry, with a freely movable plunger, is used to pass about twenty cubic centimeters of air into the balloon. If the balloon is in the duodenum, peristalsis will constrict the balloon and cause the plunger of the syringe to move backward, often in rhythmic movements. If in the stomach, the plunger will not move or will be forced all of the way back by the constant tonic contractions of the stomach.

When it is certain that the balloon is about ten inches into the duodenum, Johnston (75) advises filling the balloon and letting peristaltic activity carry the tube downward. Klein (82) advises filling

the balloon with about thirty cubic centimeters of air and then to feed the tube into the nare at a rate of three to six inches every fifteen minutes.

Miller and Abbott (102) suggest that a suction sixty centimeters of negative water pressure be used following Wangensteen's (147) method. They also suggest (101) that the proximal tubes be of different colors in order to facilitate the determination of which tube is attached to the balloon and thus prevent mistakes.

After the tube is in the duodenum and past the ligament of Treitz, Abbott, Zetzel, and Glenn (5) state that there should be no fear of reverse peristalsis, for in their studies they have not observed this below the ligament of Treitz.

The tube, after installed in the intestine, should be kept under constant suction, for Noer and Johnston (110) find that clogging kinking may leave the patient in a more serious condition than before intubation had started. The tube should be irrigated every six to eight hours, or when needed, with about fifteen cubic centimeters of water in order to keep the small holes at the end of the tube from becoming blocked (Morton, 105).

It may be seen from the above description that careful attention to detail is needed for maximum

results from the method.

Theory of Action.

Abbott and Miller (4) state that the balloon was employed in order to stimulate peristalsis and to propel the apparatus through the intestine. This is accomplished in the majority of the cases in approximately three or four hours. Klein (82) has observed that the rate of advance throughtthe intestine is one centimeter a minute in normal cases, and one-half centimeter a minute in obstructed cases.

Abbott, Zetzel, and Glenn (5), in their studies on the motor activity of the small intestine, have noted that proximal to the obstruction there is a regular series of changes in the motor phonomena taking place. There is a hypertonicity of the gut, which is followed by a distention which progresses orad as time passes. They find that as effective peristalsis requires an initial relaxation, the amplitude of peristalsis is greatest in the zone that likewise moves progressively orad, and this area is located in that part of the intestine in which the muscles fibers are beginning to be stretched by the advancing distention.

They (Abbott et. al., 5) found that in every case that they studied, except one aremia case, in

which peristalsis was lacking, or markedly decreased from mechanical or paralytic causes, the activity increased with decompression of the distended intestine.

Noer and Johnston (110) state that the tube acts, in paralytic ileus and in cases of great distention, through first decompressing the loop of gut and thus enabling normal tone to be regained.

Noer and Johnston (110) find that relief of distention is the ultimate aim of most of the methods of control of obstruction, and Johnston (76) continues that all of the methods have this principle, but vary at the level at which the decompression is maintained. In Miller and Abbott's method of aspiration, with the tip at the level of the obstruction, adequate aspiration may be considered the same as an enterostomy with two advantages over an enterostomy. The first is that the method is an internal method with no chance of peritoneal soilage, and second, the level of the aspiration may be changed at will.

Indications and Advantages of Intubation.

Abbott (1) finds that the method is useful in emptying the intestine and restoring peristalsis, in supplying data for restoration of the electrolytic balance, in relieving obstruction, in identifying and locating the nature of the lesion, in simplifying

the surgical technic, in protecting suture lines after operation, and in converting surgical procedures from an emergency into an elective procedure.

As has been stated before, Abbott et. al. (5), have shown that peristalsis is first more effective and then abolished by progressive distention in the presence of progressive mechanical distention. There is, going orad from the obstruction, first, a zone of absent peristalsis, then, a zone of hyperperistalsis. This process is reversable until there is a death of the tissues. Britton (17) has found that distention renders the peristalsis incompetent. Abbott (1) states that, due to the decompression, the tube is enabled to restore the peristalsis. He observes that absence of the motion may be a toxic manifestation, but is most frequently restarted after decompression.

Abbott (1) finds that frequently patients are admitted in shock, the extremities cold, blue and with a rapid thready pulse. In such cases, after decompression there is an improvement of the situation, but that it is important to restore the water balance and serum protein. The accurate replacement before intubation depends upon blood reports which are slow and of not much use due to rapid changes of the

condition, and the critical need for hour-to-hour information of the patient's condition. He finds intubation of value to roughly measure the salt level of the body fluid since the intestinal fluid roughly equals the salt content of the blood plasma. This may be determined by titration.

Wangensteen (153) reports that decompression of the stomach and duodenum will occasionally result in relief of the lesion. Abbott (1) finds that this is more frequently seen after aspiration of the entire small intestine above the lesion. In cases of inflammatory obstruction, if the patient is kept alive long enough, the decompression will promote free movement within the coils and a subsidance of the inflammatory edema. He states that in some cases it may be important to operate and remove an abnormal structure, but this is less frequent than with gastro-duodenal drainage.

When surgery is done, it is difficult to handle distended thin-walled loops of gut which bulge through the wall. It is true that the gastro-duodenal decompression may relieve this distention, but the intestinal decompression will give flat and empty intestines down to the site of the obstruction. If multiple obstructions are present, Abbott (1) suggests

that the surgeon may manouver the tip of the tube during the operation and thus a complete decompression results.

Lafstrum and Noer (90) have stated a fact well known by all familiar with intestinal obstruction. They urge that in any obstruction the use of barium meal by mouth is most dangerous, for it will certainly cake and cause a very difficult operative procedure. They suggest that the actual site of the obstruction may be injected by a barium mixture through a Miller-Abbott tube, and then removed again before absorption causes it to cake. They state that fifty cubic centimeters of the highest viscosity solution that will pass through the lumen of the tube be used. This procedure, according to Abbott and Johnston (3), is useful in locating the lesion and often helps in the diagnosis of the nature of the same.

Abbott (1) finds that intestinal intubation is an admirable method for the protection of suture lines from internal pressure. In long standing partial obstruction of the intestine, the wall is as thin as tissue paper, and there is danger of a leakage of sutures if placed in this kind of intestine. If the tube is kept above this suture line during convalescence,

it is possible to keep it decompressed and empty, yet possible to administer food by mouth soon after operation.

Abbott (1) states that intubation converts an emergency into an operation of election, but Cutler (3) reminds the surgeon that as soon as vomiting disappears and the stomach is empty, the patients feel more comfortable, and even in the fact of continuing strangualtion, will seem so benefitted that further delay may seem justified. He finds that this critical point must be weighed in the scales with every individual patient, and emphasizes that "much better early surgery by a mediocre surgeon than late surgery by a master."

Johnston, Penberthy, Noer, and Kenning (77) answer the objection that it takes time to intubate the intestine, and that since it frequently is impossible to pass the pylorus, why not use the duodenal tube? They state that when the tube is in the stomach, and if there is suction, the Miller-Abbott tube is as effective as a Levin tube and should be installed as soon as operation is thought of. Morton (105) thinks that any case of ruptured viscus should be an indication for the instillation of the Miller-Abbott tube, because at this time

there usually is some peristalsis left, and the passage of the pylorus is much easier.

Johnston (75) finds that the Miller-Abbott tube is indicated in low obstructions over the gastroduodenal decompression because the duodenal decompression can remove only material forced up from below, and thus tension is required to reverse the flow. The intestinal intubation, on the other hand, decompresses as it goes, and as a result is much more advantageous than the duodenal aspiration.

Wangensteen (152) states that the only advantage that enterostomy hasover duodenal decompression is that it enables mouth feeding and utilization of the absorptive area of the intestine above the tube. Knowing that Abbott, Karr, and Miller (2) have found that the major absorptive area of the intestine is above the tip of the tube when it is in the jejunum, and considering Johnston's (75) statement that the Miller-Abbott tube is an internal enterostomy, Johnston (110) found that it is possible to feed the patients by mouth after the tube is past the jejunum. Penberthy, Johnston, and Noer (126) have built up a low residue diet for feeding patients by mouth after the balloon passes the ligament of Treitz. The diet is shown on page 96.

Long Tube Diet (Low Residue. High Protein)

	Approved	Normal Optimatum
Fiber	1.7 gm.	4 - 6 gm.
Calories	2085.0	2000
Protein	89.6 gm.	70.0 gm.
Fat	103.5 gm.	80.0 gm.
Carbohydrate	196.8 gm.	250.0 gm.
Minerals:		
Calcium	.56gm.	.09gm.
Phosphorus	1.17gm.	1.23gm.
Iron	10.4 gm.	13 - 14 gm
Vitamins:		
A	8240 IU	3000-3800 IU
B	134	300
C	1958	2000

Penberthy, Johnston, & Noer (126)
(Dept. Nutrition. Detroit Receiving Hospital).

Sample Diet List

Breakfast:

Strained fruit juice
Farina with cream and sugar
Egg, bacon or ham
White bread, toasted
Butter, jelly
Coffee or tea

Luncheon:

Strained cream soup or broth with soda crackers
Meat, fowl, fish or cottage cheese
Potato, rice, spaghetti or macaroni
Strained cooked vegetables
White bread, butter
Dessert: choice of strained cooked fruit, plain puddings, vanilla ice cream, or plain cake or cookies
Coffee or tea, with cream or sugar if desired

Dinner:

Follow luncheon plan

> Custards, puddings, soups containing milk are served, but milk as a beverage is not given for fear of curds clogging the tube.
>
> Penberthy, Johnston, & Noer (126)

Johnston (76) suggests another condition in which intestinal intubation is of value. He finds that incisional hernias may be repaired after decompression by the use of the intubation.

Complications and Contra-Indications.

This method has the contra-indications of the gastro-duedenal method, intthat this method should not be used in strangualtion obstructions as the only method of treatment, but operation should be performed early. Johnston (75) finds that although the tube may break more adhesions than operative manipulations, it must be remembered that the method, per se, does not attack the cause, and as Cutler (30) stresses, the patient will feel better and surgeon and patient are often lulled into a sense of security until it is too late. Therefore, operation is the only method of treatment of strangulated obstruction, but intubation is of use in pre and post-operative care.

The tube cannot be depended upon to pass the ileo-cecal valve and to decompress the large intestine,

although frequently the balloon is observed at the anus. Noer and Johnston (110) state that it should not be used in obstructions of the large intestine.

Babcock (9) finds that the Miller-Abbott tube with roentgen studies has too limited a therapeutic value to justify the routine use in the very ill patient. He finds that twelve hours of manipulation is frequently required to pass the tube producing great exhaustion to the patient. Johnston, Penberthy, Noer, and Kenning (77) state that with the tube in the stomach, and with suction present, it would be as effective as the Levin tube, and that it should be used instead in cases in which complete decompression of the small bowel would be of benefit.

This method as with any inlying catheter method might cause ulcerations in the upper parts of the alimentary canal that were noticed by Paine (123). Klein (83) finds that after a few days of intubation there may be a soreness in the throat that may be helped by saline irrigations. He suggests aboline to keep the nares from becoming dry, and thus prevent crusting and erosions. Johnston (75) finds that the uncomfortable irritation to the nose and throat can be controlled by lubrication or by use of one per cent nupercain to the nostrils.

Laefstrom and Noer (90) find that the coiling of the tube in the stomach is the most frequent cause of failure to pass the pylorus. They suggest attention to detail at this stage and with proper management the tube will often pass the pylorus readily.

Johnston (76) finds, as does Paine (122), that the intubation through the nose, in children, is apt to result in otitis media and suggests the intubation through the mouth in these cases.

Indications of Discontinuance.

The indications for discontinuing suction in this methos are like those found in gastro-duodenal decompression and discussed in the previous chapter. The passage of flatus, and the presence of gas in the colon are the major indications for discontinuance. As with the Wangensteen method, the tube should be clamped for a few hours at a time before removal. In this method, however, the balloon may be passed all of the way through the intestinal tract and appear at the anus. This may be taken as an indication for removal.

Chapter VII

OXYGEN DECOMPRESSION

Introduction.

Fine, Banks, Sears, and Hermanson (51), in 1936, found 95 per cent oxygen inhalations to be of great value in the treatment of distention. They suggested its use in cases where the usual methods of decompression are contra-indicated, or as a part of the supportive therapy during decompression. They obtained good results in five of seven cases of distention treated by 95% oxygen over a period of eight to twenty-four hours.

Theory of Action.

Sine and Starr (52) find that an analysis of the gases present in the distended loops of intestine disclosed the presence of carbon dioxide, oxygen, hydrogen sulfide, hydrogen, methane, nitrogen, and the volitle tertiary amines. The carbon dioxide seldom exceeds that amount found in the blood, unless the circulation of the gut is disturbed. There is a rapid absorption of the oxygen of the swallowed air, so that its concentration is very near that of the blood stream. Hydrogen sulfide, which is formed from peutrifaction of proteins, is rapidly absorbed.

The hydrogen formed from fermentation reactions is also rapidly absorbed. They (Fine and Starr) find that nitrogen is the least absorbable gas present, and therefore the most important gas found in distention. This gas comes from the swallowed air and from diffusion from the blood. They have found that when swallowed air is prevented, nitrogen is at the minimum, but its diffusion from the blood stream is not averted.

Fine and his associates (50,51,52) find the Wangensteen method excellent for the removal of swallowed air, but it does not remove much of the gases present in the distended loops. They find the Miller-Abbott tube is of better use in removing the gases of the distended bowel, but that method is not always successful. They suggest the use of 95 per cent oxygen by an oxylator hood for the removal of the gases, as this procedure lowers the inhaled nitrogen of the inspired air, and thus lowers its concentration in the blood stream, thereby allowing greater absorption of the nitrogen in the coils of the intestine.

Methods of Use.

Fine, Banks, Sears, and Hermanson (50) state that oxygen may be administered by use of a catheter,

but Fine and Starr (53) suggest the use of an oxylator hood, which is of special construction, in order to enable feeding or the routine care of the patient.

Complications.

Fine, Hermanson, and Frekling (51) find that intoxication from oxygen is at a minimum because the oxygen must be shut off thirty minutes every eight hours for the nursing requirements of the patient. They state that if one is apprehensive on this point, a mixture of oxygen and helium can be used.

Wangensteen (155) tried to duplicate Fine's work, using sixty per cent oxygen, but found it of questionable value in decreasing the distention. Penberthy, Johnston, and Noer (136) found it necessary to use a concentration of 95 per cent, or even more, of the oxygen to obtain satisfactory results and to decrease distention of the bowel. He concluded that its application is limited due to need for special apparatus.

Wnagensteen, Rea, Smith, and Schwyzer (160) state that the oxygen therapy as advanced by Fine and his associates is of little value, unless the treatment is accompanied by suction methods. Suction

is a much more direct approach to the problem of obstruction, and high oxygen concentration should be a secondary procedure. They find that the best indication for this type of therapy is in paralytic ileus.

Chapter VIII

SUPPORTIVE THERAPY

Water and Chloride Metabolism

Introduction.

A very important item in supportive treatment employed in intestinal obstruction is the water and salt balance. Practically all of the fluid given to the patient by the mouth is aspirated and it becomes necessary to administer fluids by para-oral routes. If the fluid requirements of the body are not maintained, Gatch (57) finds that dehydration will result. This is the chief cause of death in the untreated cases of intestinal obstruction. The patient usually dies in alkalosis with a rapid feeble pulse, decreased blood pressure, a failure of the kidneys to excrete nitrogenous wastes, and a general derrangement of metabolism. The proper administration of fluid necessitates a knowledge of the fluid and salt metabolism of the body as related to intestinal obstruction.

Water Balance.

Coller and Maddock (25) say that animals can lose practically all of the glycogen and fat and half of the proteins down to forty per cent of the

body weight and still live; but a loss of ten per cent of the body weight of fluid is serious. Death results when the losses amount to twenty or twenty-two per cent of the body weight.

In health the amount of water intake varies, but averages about 2500 cc. This may be divided into 800-2000 cc. which are drunk, 1000 cc. are contained in the water content of food, and about 300 cc. from oxidative processes. The output is nicely balanced and may be divided into three main groups. Although there are between eight and ten liters of fl uid passed into the upper gastro-intestinal tract (Orr 116, Coller and Maddock 24), Coller and Maddock (25) find that there is approximately a constant 100 cc. of fluid eliminated every twenty four hours in the feces. The urinary amounts vary with the variance of injested water, but averages about 1300 cc. The third main source of water loss is from the heat mechanism of the organism, amounting to approximately 1300 cc. from the skin, lungs and other heat dissipating mechanisms. This is necessary that twenty-give per cent heat lost by vapinzation may be dissipated. The kidneys, if functioning properly, and if plenty of water is present, will libsrate a large amount of urine of low specific gravity, but

if the intake is low, the amount of urine is decreased but it contains a higher specific gravity.

When the patient is unable to take anything by mouth, Coller and Maddock (25) find that between 300 and 500 cc. of water is all that is available. This comes from oxidative processes. They have found it necessary (24) to have 595 cc. intake for a specific gravity of 1.038 and 1439 cc. for 1.014. When there is a strain on the heat regulating mechanism it is necessary for the patient to have a minimum of 2000 cc. a day. Many times, during warm weather, vaporization losses may be as high as 5000 cc. Dehydration is indicated when urinary volume is below 500 cc., and they advise a daily output of 1500 cc. for septic conditions.

Salt Metabolism.

Salt is, according to Bartlet, Bingham, and Pedersen (12), important in maintaining the acid-base balance of the body and in regulating the water distribution through the osmotic pressure. Sodium is more important in the determination of dehydration, for following chloride depletion, Gamble and Ross (54) find bicarbonate ions replacing the chloride ions, but in the loss of sodium there is no replacement.

Bartlet et. al. (12) cite the observation of

Sherman, who found the chloride content of the body to be 0.15 per cent, or 0.248 per cent of the body weight. Gamble (53) says a great bulk of the chlorides present in the extracellular fluid, in normal cases varys from 560-630 milligrams per cent.

Ordinarily the salt balance is regulated by the diet and the kidneys. The normal intake is about 8-12 grams of salt in the twenty-four hour period.

Coller and Bartlet (25) observe that there is normally between eight and ten liters of salt fluids poured daily into the intestinal tract, yet there is only a loss of 0.2 grams of salt through the stools. The skin has a loss varying from 0.35 to 0.41 grams through insensible perspiration. Sweat causes the loss of 2 grams every hour. The excess salt of the system is excreted by the kidneys and in cases of low salt concentration the kidneys may conserve the loss to 0.1 gram of salt in twenty-four hours.

Determination of Chloride Levels.

Abnormal salt losses are found in intestinal obstruction through vomiting and aspiration methods. Gamble and Ross (54) state that if the chloride loss is in excess of the sodium, there will be a replacement of the chloride ion by the bicarbonate ion.

This will, however, result in a condition of alkalosis. Such a condition will be indicated, according to Bartlet et. al. (12), by a high carbon dioxide combining power. If there is not sufficient water present, dehydration and an elevated non-protein nitrogen will result. Water will decrease the elevated non-protein nitrogen but not the alkalosis.

If the chloride equals the sodium loss, there will be no disturbance in the acid-base ratio, but there will be dehydration and an elevated non-protein nitrogen due to retained nitrogenous wastes (Bartlet et. al. 12). The body retains urea as an effort to partially protect itself against the loss of osmotic pressure.

If the sodium loss is greater than the chloride loss, there will be an acidosis resulting, along with a loss of fluid and an increase in the non-protein nitrogen.

Coller and Maddock have illustrated by a diagramatic drawing, the results that could be expected from aspiration. (The diagram is on page 109).

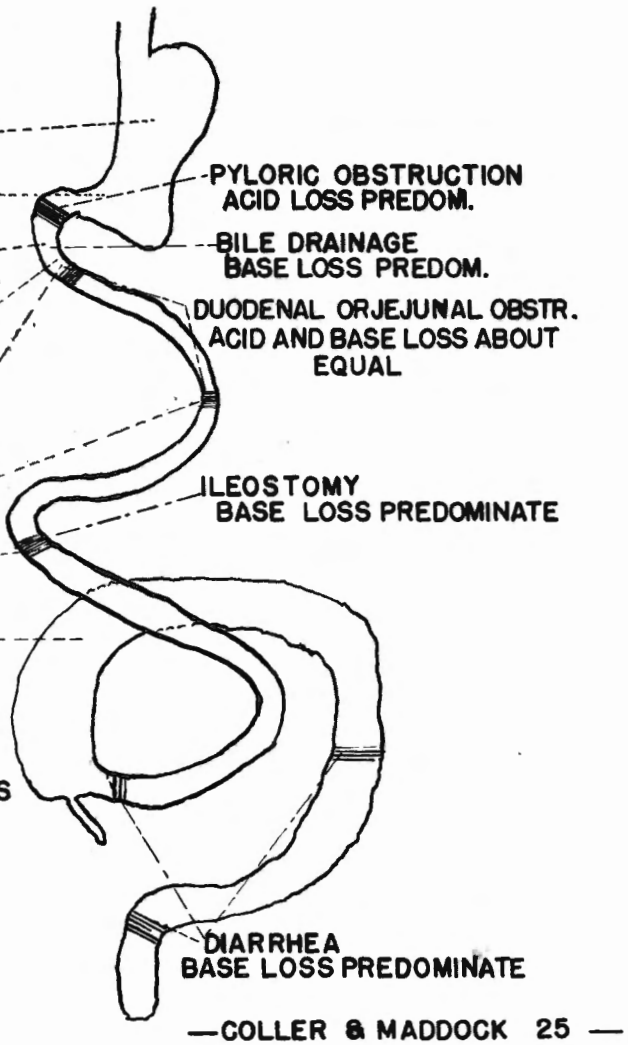
Symptoms and Complications.

Coller and Maddock (24) find that loss of body fluids up to six per cent is the start of serious dehydration. This may result in protein, casts and

erytherocytes in the urine. The urine volume in such cases of dehydration is as low as 500 cc. according to Coller and Maddock, but Northrop (111) finds that dehydration may be indicated by urinary volumes of

TOTAL BASE	Cl^-	HCO_3^+	
40	160		GASTRIC J. FUNDUS
188	142		PYLORUS JUICE
182	90	45	HEPATIC BILE
168	115	45	PANCREATIC JUICE
177	120		DUODENUM
155	150	20	JEJUNUM
162	80	90	ILEUM
160	80	92	COLON
164	110	22	BLOOD STREAM

SCHEMATIC PRESENTATION OF THE FLUID FROM THE VARIOUS PARTS OF THE G. I. TRACT AND ACID OR BASE PREDOMINATING.



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700 cc. or below. Northrop finds a rise in temperature, an increased thirst, a flushing of the face and a dry skin are symptoms of dehydration. There is an elevated non-protein nitrogen, a decreased blood vol-

ume, and a slightly elevated white and red blood count, along with an increase of the hemoglobin.

The symptoms and signs of hypochloremic are insidious at the onset and are often masked by the primary condition. Lethargy, lassitude, depression, weakness, and fatigue, according to Coller and Maddock (25), constitute the first group of symptoms. There is then a dulling of the sense of taste, anorexia, and nausea. This is followed by a dulling of the mentality, drowsiness, stupor, and coma. Finally there develops a muscular twitching and cramps. Dehydration accompanies this, and is manifest by dry tongue, sunken eyes, and a dry inelastic skin. Davis (31) states the bedside symptoms of alkalosis to be a slow shallow respiration with periods of apnea of the Cheyne-Stokes type. This is accompanied by a mild ashen-gray type of cyanosis due to anoxemia. These are frequently accompanied by tetany, with rigidity and with convulsions. The tetany, according to Davis (31) depends upon the equation:

$$\frac{Na^{+} + K^{+} + OH^{-}}{Ca^{++} + Mg^{++} + H^{+}} = \frac{\text{IRRITANT IONS}}{\text{DEPRESSANT IONS}} = \text{CONSTANT}$$

In this equation, an increase in the irritant ions or a decrease in the depressant ions will increase the irritability of the organism.

Acidosis is manifest, according to Bartlet, Bingham, and Pedersen (12) by a rapid deep breathing and a low pulse pressure. Symptoms, they find, begin when the concentration of blood chlorides is down as low as 500 milligram per cent in some, in others 450 milligram.

The diagnosis of hypochloremia depends on a low plasma chloride, abnormal loss of body fluids, and a rough estimation of the urinary chlorides (12).

Coller and Maddock (35) find that excessive salt levels are usually a result of therapy, and it is important to understand handling these cases. Normal individuals handle 35 - 40 grams of sodium chloride every twenty-four hours without difficulty, for the kidneys are able to excrete salt in the urine in concentrations up to two per cent. When patients are in good general condition they are able to handle chlorides almost as well as if normal. Excessive salt intake in the sick patient, such as one with a long lasting obstruction, frequently results in an edema. Bartlet, Bingham, Pedersen (12) find that the excess salt is retained in the interstitial tissues with enough water to equal the concentration of that normally found in interstitial fluid. They cite the observations of De Wesselow in his balance

experiments in which he studied chloride concentration and water retention. He found that approximately one liter of water was retained for every 6 - 7 grams of sodium chloride accumulating in the body. Therefore, Bartlet et. al. (12) conclude that the danger of excessive salt intake in the sick surgical patient is of pulmonary edema and edema of the other tissues. Coller and Maddock (35) think that the plasma chlorides are not reliable as an index for salt retention, as salt retention is manifested as edema rather then hyper chloremia. They state that an excess of 30 - 80 grams chloride may easily be injected, and that one method of determining this is through a routine weight chart.

Haden (63) summarizes the procedures used to determine the chemical state of the organism. He suggests a chloride determination of the plasma, a carbon dioxide combining power, a determination of the total chlorides of the urine, a total non-protein nitrogen of the urine, and a non-protein nitrogen of the blood. His chart of his findings is reproduced be-
on the next page.

Replacement Therapy.

Bartlet, Bingham, and Pedersen (12) propose three methods of replacement therapy. The first method is

by the prevention of dehydration. Trial and error is the second and usual method in determining the amount of fluid intake. They find the physician estimating the amount of fluid and chloride needed, and after administration for a chloride determination. This method has three faults. First, if the chloride concentration is taken too soon there will be a false reading, for the results require twelve hours for reporting. The second objection is that there has

CLINICAL CONDITION	SER. PR.	UREA N.P.N.	CO_2 COMB.	SALT	URIN. AMT.	URIN. N.P.N.	URIN. SALT	TREATMENT
PYLORIC OBST.	4+	4+	4+	4−	4−	4+	4−	3-5%SALT IN 10% GLUCOSE
INTEST. OBST.	3+	3+	3+	3−	3−	3+	3−	3-5%SALT IN 10% GLUCOSE
HI. INTES. FIST.	3+	3+	3+	3−	3−	3+	3−	3-5%SALT IN 10% GLUCOSE
PARALYTIC ILEUS	+	+	0	−	−	+	−	3%SALT I.V.

BLOOD & URINE FINDINGS

—HADEN 63—

been a loss of valuable time if the chlorides are low. Thirdly, if an excess is given, water is apt to be retained with the formation of edema. The third method is an attempt to scientifically replace the fluid and salt lost. Haden and Orr (118) have suggested one gram of sodiim chloride per kilogram body weight as the initial dose, but this was advanced to neutralize a toxin rather than as a replacement therapy. Orr (116), in 1937, recommended the use of 250 - 500

cc. of 2.5 - 5 per cent sodium chloride solution in patients with hypochloremia.

Coller, Bartlet, Gingham, Maddock, and Pedersen (22) find that when attempting the scientific replacement of the salt balance, that there were two groups of patients. The first group was composed of those who had a normal balance, but due to losses in the hospital and to therapy, begin to lose the balance. The second is composed of patients in whom the loss has occurred previous to entry into the hospital on account of vomiting.

In the first group it must be remembered that the concentration of salt in aspirated fluid is less than that of saline or Ringer's solution. A volume for volume replacement, using the aspirated fluid as a standard, is satisfactory for maintainence of a salt balance. Coller and Maddock (25) suggest, therefore, the measurement of the amount of drainage, and then a volume for volume replacement after the first twenty-four hours. The experiments of Coller et. at. (22) showed a marked drop in the chlorides the first twenty-four hours and found that 1000 cc. of normal saline during the first twenty-four hours corrected this drop.

The second group, those entering the hospital

with low chlorides, require a substantial amount of salt. Bartlet, Bingham, and Pedersen (12) suggest the clinical rule for the accurate replacement. This rule is: "for each 100 milligrams that the plasma chloride needs to be raised to reach the normal level, the patient should be given 0.5 grams of salt for each kilogram body weight." Coller and Maddock (25) find that the patient's weight and the plasma chloride level are essential for the proper funcioning of the rule. Furthermore, that the rule provides enough salt to restore the level to normal if the body can handle it. Also, that the usual response to sodium administration is a prompt return of the plasma chloride level, and the carbon dioxide combining power, also that there will be an excretion of salt in the urine demonstrating a position of balance. There is still a third response noticed in patients of this second group. This is a failure to have the chloride level return to normal, and the saline thus administered produces edema. Giving more salt than the rule seems to be useless in these patients. Some, however, do respond to Ringer's solution (25).

Coller and Maddock (25) find that the dehydration is best treated by using a five to ten per cent solution of glucose in distilled water because it

has been shown by Coller, Dick, and Maddock (23) that these solutions, when administered intravenously at the rate of 300 - 500 cc. per hour are handled in the same manner as though they were taken by mouth. They also observed that very little glucose is "spilled" in the urine, because the majority of it is rapidly oxidized or is stored as glycogen. Coller and Maddock (25) think that the use of five per cent dextrose does not wash any appreciable salt from the kidneys unless there is an excess of electrolyte in the system. They suggest that the volume of urine be the indicator of how much fluid to give and that the urinary output should be 1500 cc. Wangensteen (158) suggests fluid should be given so that the output is from 800 to 1000 cc. every twenty-four hours. This amounts, he finds, to about 2500 cc. of intravenous solution. Coller, Bartlet, Bingham, Maddock, and Pedersen (22) suggest that additional fluid, after the chloride metabolism requirements are satisfied, should be given in the form of five per cent glucose until the requirement for daily output of urine is satisfied.

Intravenous therapy at times fails due to mechanical difficulties. Wood (170) suggested the saving of all vomitus and aspirated material, then, after

straining this, introducing it by protoclysis as a slow, Murphy drip enema. He argues that this method is using nature's fluid and is closely approximating nature's conservation of fluid. Roberts (130) reintroduced the material aspirated by gastro-duodenal suction and found good results after diluting the fluid so that it was hypotonic.

Blood Transfusions

Wangensteen (150) states that in cases of strangulated obstructions the pre-operative use of blood transfusions is of great value, for if the loss of blood into the infarcted tract is from 800 to 1000 cc., the chance of shock is quite prominent. He states (155) that impending shock is rarely indicated by a drop of systolic blood pressure, but may be indicated by a hurried pulse. He finds that repeated small transfusions are much more effective than fewer large ones.

Chapter IV

CASES

The following group of cases indicate the value of some of the above stated methods of treatment. They are not meant as a criticism of any one technic, but are included in this paper as a method of illustrating the various important items of this thesis.

The first five cases were obtained through the courtesy of the Lincoln Clinic and Bryan Memorial Hospital, Lincoln, Nebraska. Of these, the first four cases were observed personally. The last two cases were obtained from the University Hospital, University of Nebraska, Omaha, Nebraska.

The last case was likewise personally observed.

Case I. (172)

The first case illustrates the value of the Miller-Abbott tube in cases of generalized peritonitis.

The patient, Miss K., is a single female, 55 years of age. She entered Bryan Memorial Hospital, Lincoln, Nebraska, 6/13/39, with a diagnosis of acute appendicitis with peritonitis. At operation a gangrenous, ruptured appendix was found, with generalized peritonitis. The operation consisted of

appendectomy, pen-rose drain into the peritoneal cavity and a separate drain to the wound. Peritoneal fluid was not cultured but there was a definite colon oder to the pus.

Postoperatively the patient showed a gradually increasing distention in spite of the routine use of pitressin, but there was no vomiting. On the fourth postoperative day a Wangensteen tube was passed. The following day there was no relief from the distention and the Miller-Abbott tube was passed. Two days later the tube was still in the stomach and the patient was still distended. The following day analysis of the blood chemistry revealed a blood urea of 52.4 mgms. % and the blood chloride 525 mgms. %. The X-ray at this time showed the loops of the small bowel distended but the tube had entered the duodenum. This tube was gradually fed into the small bowel and three days later the X-ray showed it descending thru the small bowel. At this time rugar (a special barium preparation) was injected thru the tube and revealed that there was no obstruction beyond the tip of the tube. The patient's general condition was very much improved. The patient began taking fluids and very shortly thereafter semi-solid food. She was having liquid

stools. Three days following the X-ray with the barium mixture, the tube was removed after having been clamped intermittently. The patient's convalescense from this point forward was uneventful.

The points illustrated by this case are (1) that it is not safe to wait for nausea and vomiting in postoperative cases before instituting treatment for paralytic ileus. (2) That it is well to pass the tube early in these cases to avoid changes in blood chemistry and before peristalsis is absent in the small bowel. It also illustrates the impoertance of getting the tube into the duodenum promptly. This could no doubt have been accomplished by the use of the fluoroscope. It also shows that feedings may be instituted early when the tube is passed into the small bowel and is working freely. This is very important in the general support of postoperative cases with general peritonitis.

Case II. (172)

Willard S., a boy, age 5, entered Bryan Memorial Hospital, Lincoln, Nebraska, 7/22/39, and was operated on for the removal of a gangrenous, perforated appendix, with generalized peritonitis. Smears and cultures showed gram positive cocci and gram negative bacilli.

Postoperative course was stormy, with fever,

rapid pulse, and distention. Pitressin was administered without benefit. There was nausea but no vomiting. Four days postoperatively the Miller-Abbott tube was passed. The following day it had not entered the duodenum and even though started into the duodenum under fluoroscopic control it refused to advance. The following day the tube was still in the duodenum and the patient was more distended.

At this time an ileostomy was performed under local anesthetic. There was a large amount of free peritoneal fluid and a large amount of fluid in the distended small intestine. The subsequent course was stormy and numerous transfusions were given to combat the inanition. The day following ileostomy the tube had entered the duodenum and gradually passed on through the small intestine. Feedings were instituted by mouth at this time, and following this there was a gradual improvement in the patient's condition.

This case again shows the difficulty of getting the tube into the duodenum when there is marked distention of the small intestine and an absence of peristaltic activity. It also shows that where the tube does fail to function properly, surgery may serve as a life-saving measure. The passage of the

tube after ileostomy shows that some peristalsis is necessary for its entrance into the duodenum. It also shows that feedings are tolerated very well when the small bowel is decompressed.

Case III. (172)

M. H., a girl, aged 9. Operated on 8/3/39, and a large gangrenous, ruptured appendix was found, with free foul-smelling peritoneal fluid thruout the abdomen. Culture and smear showed gram negative bacilli. During the first 48 hours postoperatively the temperature, pulse, and respirations remained high and the abdomen gradually became distended. The Miller-Abbott tube was passed into the stomach and remained there until the next day, when it was passed into the duodenum under fluoroscopic control. Two days later the abdomen was flat and the patient was passing flatus. The temperature and pulse had receded and the patient was generally much better. The following day oral feedings were started. The day following this the tip of the tube was passed per rectum. It was released from above and drawn through the gastro-intestinal tract. There was a gradual improvement in the patient's condition, and she was dismissed on the 16th postoperative day.

This again, shows the advantage of passing the tube early and the use of the fluoroscope in its

control.

Case IV. (172)

This case shows the great value of the Miller-Abbott tube in the diagnosis of intestinal obstruction. Mr. Wm. R., male, age 65, entered Bryan Memorial Hospital, Lincoln, Nebraska, 4/1/39, because of abdominal distress and distention of one month's duration. Ten years before he had had considerable abdominal surgery for incarcerated femoral hernia, also a direct inguinal hernia with protruding torn loop of bowel and generalized peritonitis. Following this he had had no further trouble to the present.

At the onset of his present trouble a gastro-intestinal and gall bladder X-ray study revealed a non-functioning gall bladder and pathology of the pelvic colon interpreted as diverticulitis with a possible secondary carcinoma. Upon entrance into the hospital he was considered to have a partial low grade obstruction. The Miller-Abbott tube was passed. A large amount of bile-stained fluid was aspirated during the first few hours. The tube gradually passed through the small bowel and the first portion of the colon. A special barium mixture was injected and X-ray study made.

This case illustrates very beautifully the value of the Miller-Abbott tube in the treatment of low

grade intestinal obstruction, and also its value in ruling out an obstructive lesion of the small bowel and first portion of the colon.

The patient was dismissed on his eleventh day. He re-entered eleven days later with acute cholecystitis and was operated on his fifth hospital day for this added condition. His convalescence was uneventful.

Case V. (172)

This case had an unfavorable termination but contains valuable lessons in the management of electrolyte balance in postoperative cases.

Roy Mc., age 11, entered Bryan Memorial Hospital, Lincoln, Nebraska, on 2/24/39, with a diagnosis of acute appendicitis. At operation the same day a high-lying retrocecal, gangrenous appendix was found adherent to, and perforated onto, the posterior parietal wall very close to the normal course of the right ureter. There was free foul-smelling fluid in this area and the adjacent tissue was necrotic. The appendix was removed and the area drained.

His postoperative condition was only fair and he ran a very marked septic course. Fluid was administered in the form of 5% glucose in normal saline as a continuous intravenous drip, and transfusions

of whole blood were given at frequent intervals. On the 4th postoperative day the patient became quite distended and there was a question of abscess formation in the left pelvis. X-ray therapy for peritonitis was begun at this point. The Miller-Abbott tube was passed and entered the small bowel readily. It stopped, however, at a definite point in the ileum. Three days later he seemed definitely better. There was less distention and the mass seemed less prominent. The tip of the tube remained in the ileum and there was a questionable obstruction at this point. Three days later there was more evidence of a pelvic abscess and a large collection of turbid fluid was drained through a low inguinal incision. Because the tube had not progressed to the cecum, a tube was placed in the cecum through the bulging wound without anesthesia and without disturbing the patient. Three days later the abdomen was soft and flat and there was a large amount of drainage from both tubes. The patient was continuing to receive intravenous fluids, whole blood and neoprontosil. At this time it was noted that the extremities and back were becoming somewhat edematous. There were also impetigo-like lesions over the body. He gradually became more comatose and expired the following day. Post-mortem examination

revealed a generalized peritonitis, abscess along the right gutter and adhesions of the ileum.

The lessons which one might learn from this case are that the tube was used somewhat late in the course of the peritonitis. The abscess might better have been drained at an earlier date, but above all the fact that too much sodium chloride was undoubtedly used in this case, as evidenced by the edema in spite of good cardiac action and the use of repeated blood transfusions.

Case VI. (173)

A. A., a Negro, male, married, age 37, entered the University Hospital complaining of pains resembling gas pains in the region of the umbilicus of sudden onset.

The patient had been dismissed from the hospital about one week previously following an operation for release of adhesions. On January 22, 1940, at 3:00 p. m., while he was at rest, he was seized with an acute abdominal discomfort resembling "gas pains" in the lower abdomen. The pains would increase and then remit, but persisted without abatement. There was no nausea and vomiting accompanying the pain. The patient had a normal bowel movement on the morning of the hospital entrance. He had to take an enema at

7 p. m. The morning stool was yellowish in color. He did not note the character of the evening stool, but gas was expelled following the enema. The patient had an appendectomy in 1937. On January 5, 1940, the patient entered the University Hospital with acute distress and nausea and vomiting. A diagnosis of obstruction was made and the patient was operated on that same afternoon. The postoperative course was uneventful and the patient was dismissed on 1/15/40.

The patient was a well-developed male, lying in bed and complaining of considerable abdominal discomfort. The abdomen was distended. There was a marked tenderness just below and to the left of umbilicus. No rigidity. There was a visible mass beneath the area of tenderness.

The day of second entry into the hospital the patient was operated on and the adhesions were freed. A small perforation was noted at time of operation, and there was some seepage of material into the peritoneal cavity. The wound was closed and drained. The patient received morphine and scopolamine preoperatively and 1500 cc. of five per cent glucose in normal saline intravenously immediately after operation. The following day the patient was distended and a gastroduodenal and a rectal tube were inserted. The second day the temperature reached 105.2 degrees but

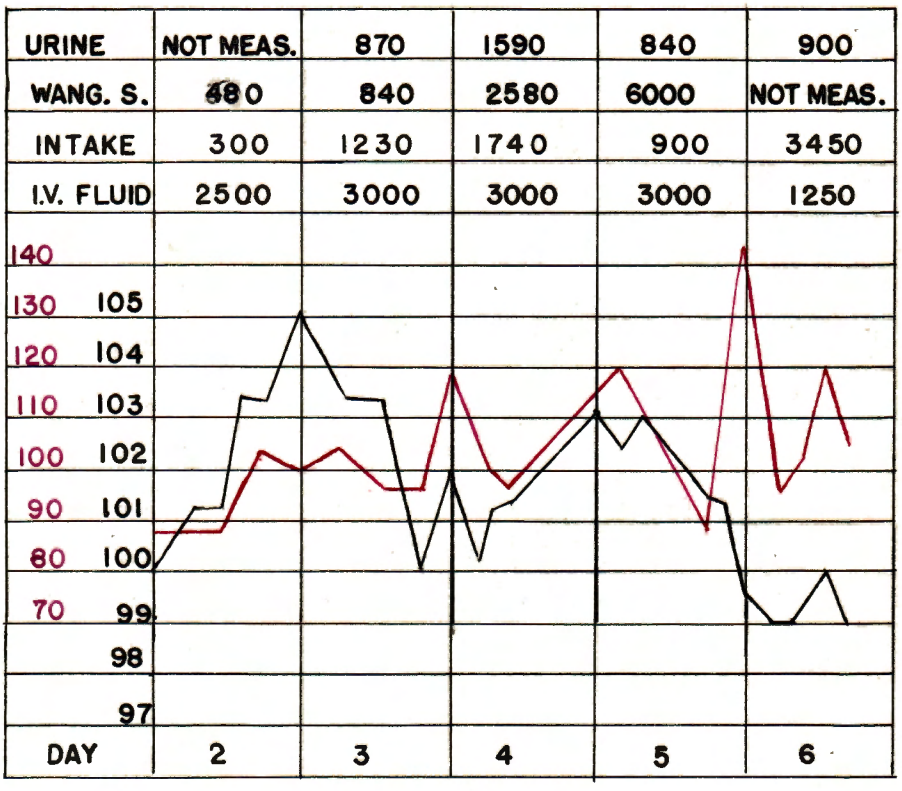
fell to 102.2 degrees the next day. The patient felt much better the third post-operative day, but the abdomen was still tender and slightly distended. The Wangensteen tube was removed the fifth postoperative day because temperature had fallen back to normal, and after closing the tube no distress was noticed. The following day the patient had a sudden dizzy spell and the patient's pulse became rapid and thready. The respiration was gasping and the patient lost consciousness. Death resulted.

This case illustrates Wangensteen's statement that decompression should be done before operative removal of adhesions. The tear in the bowel noted at operation may have been due to the operative manipulation.

The urine volume was kept just below 1000 cc., but might have been higher for possibly dehydration had a not unimportant role in the exodus.

The decompression was not followed by roentgenograms, and accurate knowledge of the condition was not known.

This would have been a good case for intestinal decompression preoperatively followed by decompression in the postoperative period if followed by films and adequate fluid therapy.



CASE NO. VI.

— UNIVERSITY HOSPITAL OMAHA—

Case VII. (173)

Melvin R., age 11, entered the University Hospital, 2/29/40, complaining of pain in the abdomen for six days. The patient vomited a sour, bitter green vomitus four or five times, five days before entry into the hospital. Pain and tenderness became localized in the right lower quadrant three days before entry, and necessitated the use of an ice bag on the abdomen.

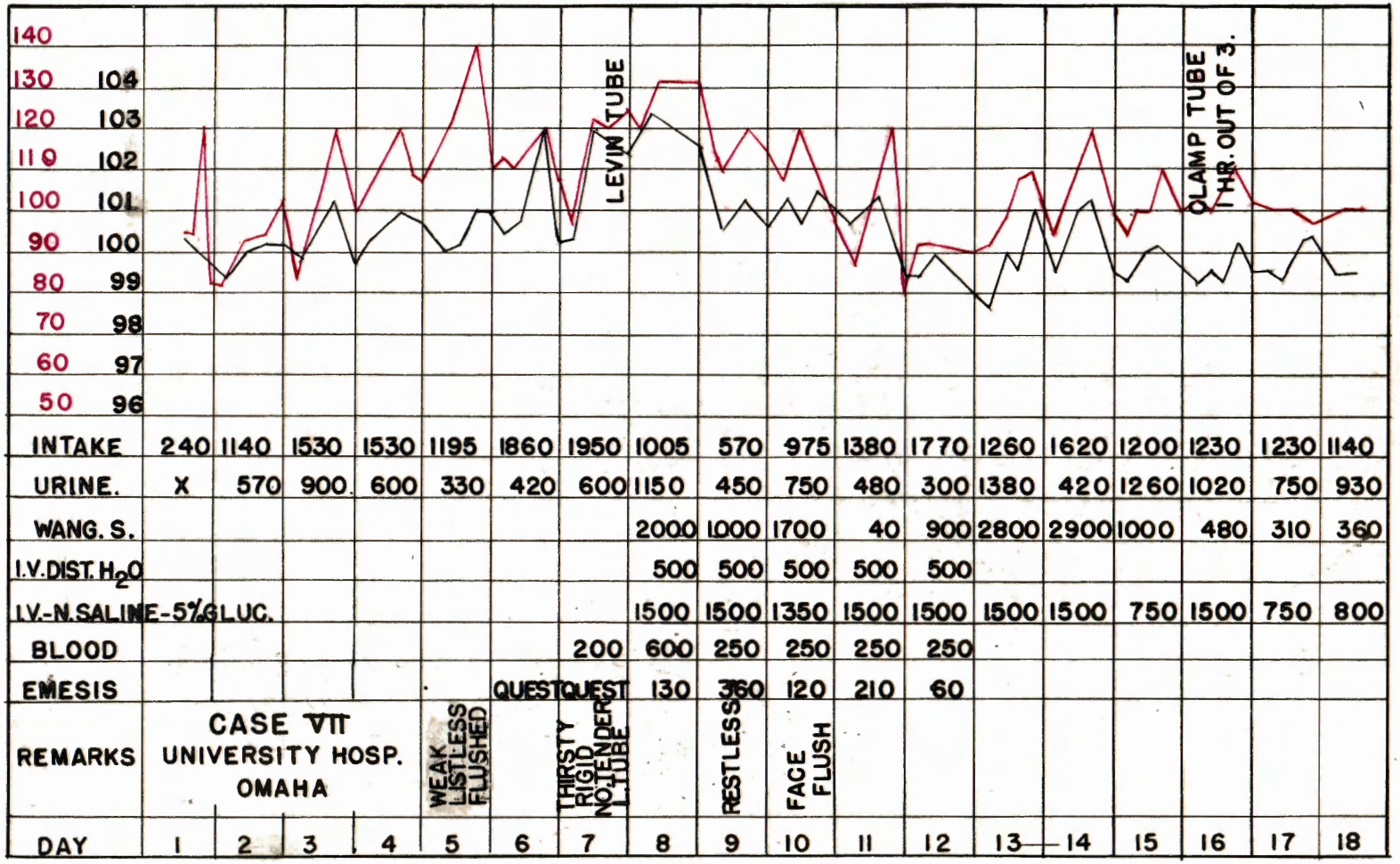
On physical examination, no motion was noted in the right lower quadrant. There was a bulging over McBurney's point about the size of a turkey egg, and the white count was 15,600.

A diagnosis of appendiceal abscess was made and it was decided to treat the patient with hot packs to the abdomen and neoprontosil. March 4, five days after entry, a loose, black diarrhea stool was passed, associated with nausea and vomiting. Seven days after entry the patient vomited all his dinner and complained of severe pain in the right lower quadrant. The mass had disappeared, the temperature was 103, the pulse, 120. The patient appeared pale and as though in shock. Wangensteen drainage was started and intravenous therapy was instituted. Hot packs to the abdomen were continued. Small daily transfusions instituted and the next day roentgen therapy was applied

to the abdomen. On the fourteenth hospital day the patient's abdomen had decreased and was not tender. On the sixteenth hospital day the Wangensteen tube was begun to be clamped off. The patient is still in the hospital.

This case demonstrates the value of the statement that any ruptured viscus should be an indication for decompression (Morton, 105). The distention from an apparent ileus might have been prevented had a Wangensteen tube or a Miller-Abbott tube been utilized immediately.

This case shows the drop of temperature following an adequate fluid course in conjunction with aspiration.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LEVIN TUBE
CLAMP TUBE THR. OUT OF 3.
INTAKE 240 1140 1530 1530 1195 1860 1950 1005 570 975 1380 1770 1260 1620 1200 1230 1230 1140
URINE. X 570 900 600 330 420 600 1150 450 750 480 300 1380 420 1260 1020 750 930
WANG. S. 2000 1000 1700 40 900 2800 2900 1000 480 310 360
I.V. DIST. H_2O 500 500 500 500 500
I.V.-N. SALINE-5% GLUC. 1500 1500 1350 1500 1500 1500 1500 750 1500 750 800
BLOOD 200 600 250 250 250 250
EMESIS QUEST QUEST 130 360 120 210 60
REMARKS CASE VII UNIVERSITY HOSP. OMAHA
WEAK LISTLESS FLUSHED
THIRSTY RIGID NO TENDER L. TUBE
RESTLESS
FACE FLUSH
DAY 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Chapter X

SUMMARY AND CONCLUSIONS

Decompression methods originated in Roman times with the use of drugs as a method of emptying the stomach. John Hunter is given the credit for the first recorded intubation of the stomach. Kussmaul popularized the use of the stomach pump in 1869. Early research in intubation was directed along the lines of treating poisoning and obtaining duodenal secretions. Wangensteen popularized suction siphonage of the duodenum in 1931, and Miller and Abbott, in 1934, presented their method of intestinal intubation.

Early diagnosis of intestinal obstruction is important and depends upon the history, short intermittant pains, vomiting of a reflex character, early moderate distention which later becomes severe, a relation of borborygmi to the colicky pains, and roentgen findings of gas in the small bowel.

Intestinal obstruction is, for clinical purposes, divided into simple and strangulated obstructions. Simple obstructions do not have an embarrasment of the blood supply, but strangulated ones do. Differential diagnosis depends on the appearance of the patient, shock, (if present), peritoneal irritation and rebound

tenderness, rigidity of the intestinal wall, leukocyte count out of proportion to the abdominal findings, the presence of a serosanguinous fluid on opening the abdomen, and the presence of a purplish discoloration to the bowel wall which may or may not return to normal.

Surgery should be instituted in cases of strangulated obstruction, but if there is an absence of the serosanguinous fluid, curiosity of the nature of the obstruction should be stifled and decompression should be instituted.

If the bowel is strangulated and does not return in color of if there is no puslation to the vessels, it is devitalized and should be resected.

The condition of the bowel after the release of a mechanical obstruction of a strangulated loop often determines the decision for enterostomy. If there is no embarrasment to the blood supply, but no return to normal after liberation of the constricting bands then an enterostomy may be performed.

The procedure of enterostomy is attended with considerable risk, as there is especially the danger of producing shock, contamination, and injury to the intestinal wall.

Enterostomy is never indicated in paralytic

ileus or when intubation decompression may be accomplished, but should be held in reserve as a treatment of election that should be used if conservative decompression fails. In performing an enterostomy, the Witzel technic is the best and minimizes the danger of peritoneal spillage. Stripping of the intestine during the operative relief of the obstruction will empty the intestine of its contents but is accompanied with danger.

Gastro-duodenal aspiration has a definite role in the treatment of intestinal obstruction. Its intelligent use depends on the ability to recognize and differentiate simple and strangulated obstructions and the appreciation of the importance of scout films for the location of the obstruction and the determination of whether or not the obstruction is complete or imcomplete. A series of films are also important to determine the condition of the patient during the decompression. Finally, its intelligent use depends upon the appreciation of the limitations of the method.

Duodenal decompression is a valuable method of decompression in cases requiring surgery for it decreases distention so that the operative manipulations are safer and easier. The sense of relief encountered

after the use of decompression should not be a factor in determining whether or not an operation is indicated, but in persistant adhesive obstructions or in doubtful strangulated obstructions surgery with negative findings is much better than no surgery and a strangulated obstruction.

Duodenal aspiration avoids pulmonary aspiration and should be continued during the time of the operation. It is often an effective treatment in peritonitis and may obviate the necessity of an enterostomy. It is of particular value in the prevention of post-operative adhesions of the bowel.

The greatest value of duodenal aspiration is in the treatment of paralytic ileus and in the prevention of the post-operative distention through its early insertion in order to prevent swallowed gases from accumulating.

Duodenal decompression is not effectual when there is an interspersion of segments containing collections of gas and fluid. It does not, however, remove the gases and distention from the lower reaches of the small intestine.

Duodenal and intestinal intubation are contra-indicated as the only treatment in strangulated obstructions and should not be used in obstructions of

the large bowel.

A double lumen tube, or a pair of tubes may be passed rapidly down, either a normal or an obstructed small intestine by inflating in the duodenum a rubber balloon on the end of a tube to a degree to stimulate a propulsive peristalsis. This action takes places whether the obstruction is due to infection, mechanical occlusion, or paralytic ileus. The gas and fluid may be aspirated from the entire length of the small gut by the application of constant suction as the tube advances, resulting in a relief of the distention.

Speed in the intubation of the intestine is dependent upon the attention to detail during the insertion of the tube, and with care and practice the rapid passage of the pylorus may be accomplished. If the tube does not pass the pylorus, it is as effective as a Levin tube in the stomach if constant suction is maintained. Therefore, in cases in which intestinal intubation would be of value, the intestinal tube should be inserted instead of the Levin tube, for it has all of the advantages of the Levin tube, and in addition, the potentialities and advantages of an intestinal intubation.

Intestinal intubation may be used to carry the

patient past the period of operation. It may be used in preparation of the patient for operation, and thus, in relief of the distention, make the operation less traumatic and easier for the surgeon. It may be used as a means for the localization and the diagnosis of the obstruction by the use of a small amount of barium inserted at the site of the obstruction. Intestinal intubation permits feeding the patient during a period when food and fluid is important. It may be used to relax the tension of the intestine above the site of the obstruction and frequently re-establishes the passage of the intestinal contents and thus permits an interval operation. Intestinal intubation is of value in relaxing the tension on suture lines that are placed in the gut. It is of such great value in the prevention and the treatment of paralytic ileus that its insertion should be indicated in all cases of a ruptured viscus on entry into the hospital.

Ninety-five per cent oxygen, when used in conjunction with decompression methods is of value in the relief of gaseous distention of the small bowel in intestinal obstruction.

Dehydration and an upset salt balance due to continuous suction methods and vomiting are the main

factors in toxic symptoms found in intestinal obstruction. The intravenous injection of volume for volume of normal saline after the first twenty-four hours is sufficient to maintain the salt level. In order to replace salt that has been lost previous to the entry into the hospital, the chlorides may be restored to a normal level by giving one-half gram of salt per kilogram of body weight for each 100 points in milligrams per cent that they are below normal. Dehydration is combatted by the use in sufficient volumes of five per cent glucose in distilled water in order to bring the urinary volume up to the minimum of 1000 cc. every twenty-four hours and to 1500 cc. in the very sick patient. ten per cent glucose is used if more calories are desired. Excesses of salt in the patient with intestinal obstruction is apt to cause a general tissue edema.

Repeated blood transfusions are of value in restoring the serum protein and in maintaining the blood volume at a high level. Shock is combatted in this manner. Repeated small transfusions are much more valuable than large less frequent transfusions.

Seven cases are included in order to demonstrate the handling of the problem of intestinal obstruction

and are discussed in view to the problem of better handling. In the preparation of the cases it was noted that there is a failure to record the amount of drainage from the suction apparatus and that it was often impossible to determine an accurate salt and water balance on the patient because of this fact. It was also noted that roentgen following of the decompression was not done, but the patients were followed by physicial and diagnostic signs alone.

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