1955

Acquired mechanical large bowel obstructions

Albert James Brauer
University of Nebraska Medical Center

ACQUIRED MECHANICAL LARGE BOWEL OBSTRUCTIONS

Albert James Brauer

Submitted in Partial Fulfillment for the Degree of
Doctor of Medicine

College of Medicine, University of Nebraska

April 1, 1955

Omaha, Nebraska

ACKNOWLEDGEMENTS

I wish to express my thanks to Dr. Carlyle E. Wilson, who has worked so conscientiously and intelligently with me in the production of this thesis, and to my wife, who has devoted much time, thought, and energy to the final preparation of this paper.

Albert J. Brauer

TABLE OF CONTENTS

INTRODUCTION

One of the most perplexing problems encountered in general surgery is that of large bowel obstruction. This entity is not rare. Every physician should learn to recognize this condition early in its course, so that treatment can be instituted as soon as the patient can tolerate an operative procedure.

This subject was chosen for study for three reasons. First, it is one of the most difficult problems the general surgeon has to handle, hence an increase in knowledge of management of the problem is necessary; secondly, the intestinal physiology, pathology, and surgical management learned here can be applied in some degree to other intestinal disorders; and thirdly, the recent developments pertaining to this subject have not been incorporated in book form for thirteen years. An up-to-date survey of the problem is therefore desired.

The objective of this thesis is to review the recent literature in regard to etiology, diagnosis, and management of the acquired mechanical large bowel obstruction.

ETIOLOGY

GENERAL

In order to make this discussion as organized as possible, a general classification of all types of intestinal obstruction will be presented.

TABLE 1

CLINICAL CLASSIFICATION	PATHOLOGIC CLASSIFICATION
I. Mechanical A. Narrowing of lumen 1. Strictures of bowel wall a. Congenital Atresia Imperforate anus b. Aquired Inflammatory Traumatic Vascular Neoplastic 2. Obturation 3. Compression from without (especially pelvis and retroperitoneal duodenum)	Simple except in neoplastic strictures of the colon.
B. Adhesive bands Congenital Inflammatory Traumatic Neoplastic	Simple or strangulation
C. Hernia 1. External 2. Internal D. Volvulus E. Intussusception F. Errors in development of the intestine giving rise to intestinal obstruction	Strangulation
II. Nervous (physiological imbalance) A. Inhibition ileus-(paralytic) adynamic B. Spastic ileus-dynamic	Simple
III. Vascular Thrombosis and embolism of mesenteric vessels	Strangulation

INCIDENCE. As was stated above, large bowel obstruction is not rare, but it is also true that it is not a common lesion. According to Christopher (1) the Massachusetts General Hospital

statistics indicate that the incidence of all intestinal obstructions is approximately from .8%-1% of the surgical admissions. Michel (2) states that the ratio of small bowel to large bowel obstruction is 5-6:1. Therefore, about one out of every 500 patients admitted to the surgical service will have a large bowel obstruction. The average practicing surgeon will treat approximately twenty cases in a lifetime.

The most common cause of colon obstruction is primary carcinoma. This lesion, without question produces at least 50% of the obstructions. Many authors state figures of 65% or more. Hendricks and Griffin (3) assert that 90% or more of simple colon obstructions are due to primary carcinoma. The remaining major causes of obstruction are volvulus and diverticulitis.

A compilation of the figures listed by eight different authors gives a complete statistical record of the comparative etiological causes and the location of the lesions in the colon producing the obstruction. A total of 1219 cases were reviewed. These figures and the etiological distribution of the cases are tabulated in Table #2.

A few notes should be made concerning this table. Torell (6) points out the fact that in his series most all of the adhesive obstructions were produced by malignant processes outside the colon. Another significant finding is that in the Albers and Smith (9)

	Prim. CA.	Volv.	Diver.	Adhesions	Hernias	Intuss.	M.&U.	Total
Anglen & Kenworthy (4)	39						2	41
Howard (5)	24	6	12	14	1		20	77
Michel et al (2)	153	38	9	6	3	6	22	237
Torell (6)	41	9	2	10			3	65
Gregg (7)	110		16	10	5	9	20	170
Becker (8)	100	51	5	5	25	12	7	205
Albers & Smith (9)	100	24	34				82	240
Hendricks & Griffin (3)	170	12		1			1	184
	737	140	78	46	34	27	157	1219
	60.7%	11.5%	6.4%	3.8%	2.8%	2.2%	12.6%	

Table 2

NOTE: Hernias - external strangulated only.
M.&U. - Miscellaneous and Unknown.

series, 34 of the 240 cases were produced by fecal impaction. In Howard's (5) series, 4 of the 77 obstructions were produced by fecal impaction.

The incidence stated for intussusception in this group is probably somewhat low since some of the authors did not include the ileocecal type intussusception.

The major single cause of obstruction in the miscellaneous group is the extrensic bowel lesions such as carcinomatosis and pelvic abscess.

The etiology of volvulus and intussusception should be discussed in greater measure since these entities will always eventually produce a partial or complete obstruction.

VOLVULUS

In volvulus one basic anatomical defect is present which predisposes the bowel to torsion. This defect is a long redundant mesentary which is excessively mobile. Howard (5) mentions another factor. Since volvulus is most common in the older age group, he believes the loss of mesentary fat plus a long loop creates a situation for possible torsion. In volvulus of the cecum the posterior mesentary does not become adherent to the posterior abdominal wall, allowing torsion of the ascending or hepatic flexure segments of the colon. Volvulus can occur anywhere in the colon or involve the whole colon, providing an abnormally long mesentary is present. The most frequent location is in the

sigmoid, followed by cecal and ascending colon volvulus. Gerwig (10) reports a total of 17 cases of transverse colon volvulus, and Buenger (11) reports only 2 cases of volvulus of the splenic flexure of the colon in a complete review of American and European literature.

Many ideas have been proposed as to the precipitating factors in volvulus which will not be discussed in this thesis. It is interesting to note that several cases of volvulus have occurred during labor. Russell (12) reports such a case of volvulus of the cecum which ruptured during violent labor.

INTUSSUSCEPTION

According to Nelson (13), the most common cause of mechanical intestinal obstruction in the infant and child is intussusception. In the adult it is one of the less frequent causes of colon obstruction. Only 5-10% of all intussusceptions occur in adults. This entity varies greatly depending whether it is found in a child or an adult. Deterling (14) states that 25% of adult intussusception has no etiologic cause. Brayton & Norris (15), in a very excellent article, corroborate this figure and add that 95% or more of infant intussusception has no etiology. Table #3 shows the location of intussusception in adults and children, as found by these authors.

TYPE	ADULT		CHILDREN
Enteric	39%		4%
Ileocolic	13%	29%	94%
Ileocecal	16%		
Colon	17%		2%
Cecum and appendix	4%		
Stomal type	11%		

TABLE 3

In order to picture the two types of intussusception most easily confused, the ileocolic and ileocecal types are diagrammed in Figure A.

Ileocolic Ileocecal

FIGURE A

It can be seen that 37% of adult intussusception is of colonic origin. As will be discussed later, it is very important to distinguish between ileocolic and ileocecal intussusception in adults, because the ileocolic intussusception is precipitated by

a lesion in the ileum and is therefore not likely to be malignant, while in ileocecal intussusception the lesion is in the cecum and quite possibly malignant. Brayton & Norris (15) assert that 56% of intussusception arising in the colon is caused by malignant lesions.

Lipomas are the second most common cause producing adult intussusception.

Cowart & Fort (16) report 2 cases, one of intussusception and one of volvulus following ureterosigmoidostomy.

Some of the etiological factors in infant intussusception are lipoma, sarcoma, and Meckel's diverticulum.

Cleland (17) describes a very unusual cause of intussusception. In his review he presents six cases, all under 29 years, of caecocolic intussusception following appendectomy. In five of the six cases the appendeceal stump was known to be invaginated and this formed the apex of the intussusceptum.

There are many other mechanical causes of large bowel obstructions, all of which are very rare. Some of these are gall stones, foreign bodies, and Ascaris worms.

DISTRIBUTION

Anglem & Kenworthy (4) state that 85% of the lesions producing obstruction are in the left half of the colon and this is corroborated by a composite analysis of the figures of the eight authors

listed in Table #2. The regional distribution of the primary carcinoma, diverticulitis, and volvulus lesions are shown in Figure B.

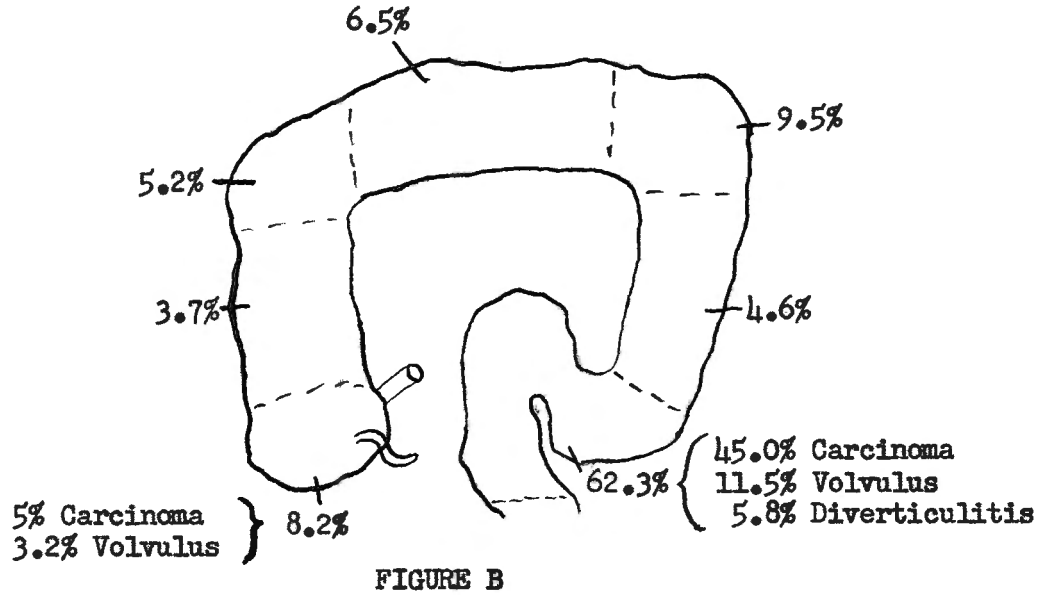

FIGURE B

DIAGNOSIS

GENERAL

The diagnosis of colon obstruction can at times be very difficult to make. In the cases in which the diagnosis is delayed, the mortality percentage increases. Therefore it behooves every surgeon to make the diagnosis early, because early diagnosis means decreased mortality!

Colon obstruction can occur at any age. In Becker's (8) series of 205 cases, the age varied from 6 days to 85 years, but

51.5% of the patients were over 60 years. Michel et al (2) states that 77% are over 50 years. More than 50% of colon obstructions are in females. In Ulin's (18) series, 70% were in women. So it can be seen that the majority of the cases occur in the old age group in which the most common lesion is carcinoma, while in the infant and child age group the most common lesion is intussusception.

The four complaints of patients with mechanical large bowel obstruction are: 1) pain, 2) infrequent nausea and vomiting, 3) distention, and 4) increasing obstipation.

The pain is produced by the enhanced activity of the gut and is characterized by the sudden onset of distress, which increases in crescendo fashion, quickly reaching its maximum grade of severity lasting for 1-3 minutes; then the pain decreases and ceases as abruptly as it began. After intervals of varying length of time, the pain recurs again and again. Concomitant with these recurrent pains, sounds of a metallic bubbling and gurgling character are heard over the abdomen with a stethoscope at the acme of the pain. The synchronous concurrence of pain and borborygmus establish the painful contraction as intestinal colic. Wangensteen (19) asserts that intestinal obstruction of mechanical origin without intestinal colic does not exist. As the colon becomes markedly distended, the pain becomes a dull, continuous type or may be so minimal that

the patient is only uncomfortable. This is true because the colon now cannot contract down forcibly.

The vomiting of colon obstruction is quite variable. Many times there may be none at all or only one or two occurrences. Usually it appears late in the course of colon obstruction. Vomiting may occur reflexly because of pain.

The amount of colon distention is dependent on several factors: 1) location of the lesion; a lesion in the cecum may give very minimal distention on obstruction and may perforate before any pathognomonic signs or symptoms are present; 2) whether the obstruction is complete or incomplete; and, 3) whether the ileocecal valve is competent or not.

STRANGULATION

Strangulation of the bowel demands an immediate and correct diagnosis so that treatment can be instituted without delay. Cole (20) lists the classical signs of strangulated bowel: 1) increase in amount of pain, 2) increase in abdominal tenderness in area of pain, 3) increase in pulse rate, 4) muscle spasm, 5) development of a mass, 6) fever, 7) leucocytosis, and, 8) decrease in blood pressure. He states that the first three points listed are the most important in making the diagnosis and surgical intervention should be begun without delay, before the latter criteria mentioned appear.

Culligan (21) has taken these classical signs of strangulated bowel which have appeared in the literature for years and compared them with those found in simple obstruction. They appear very interesting and frustrating to the surgeon who must differentiate between the two conditions. They are listed in Table #4.

	Strangulated	Simple
1. Signs of peritoneal irritation a) tenseness b) muscle rigidity c) rebound tenderness	81.8%	72.2%
2. Fever	22.7%	16%
3. Leucocytosis	50%	44.4%
4. Rapid pulse	22.8%	14.8%
5. Presence of mass	—	—

TABLE 4

Culligan adds that 60.8% of the patients who died of strangulated obstruction had a normal leukocyte count.

X-RAY AND OTHER EXAMINATIONS

Every examination for suspected colon obstruction should include a rectal, pelvic, sigmoidoscopy, and x-ray.

According to Miller (22), a thorough x-ray examination for suspected colon obstruction should include an antero-posterior and transverse film of the abdomen in the supine position and a barium enema. He believes the upright film is of little value because the loops are distorted and displaced. The patient, being very sick, will usually show movement on the film. The bucky

diaphragm cannot be used and thus a poor film is the usual result. Many radiologists will dispute this contention, for they believe the upright film is of value.

It must be remembered that a thorough x-ray examination with negative results does not always rule out obstruction. For example, in adult intussusception, only 70% of the cases give positive results with barium enema films.

Sante (23) summarizes the positive x-ray findings in large bowel obstruction as: 1) gas distended loop proximal to the obstruction with variable amount of small bowel distention depending on competency of the ileocecal valve and the duration of the obstruction; 2) flaccidity of bowel distal to the obstruction which is indicated by lack of fecal content or gas in the distal segment; 3) multiple fluid levels in the gas distended bowel; and 4) barium enema will localize the area of the obstruction in most cases.

Laufman (24) believes every patient with an acute abdominal condition should have a serum amylase done, because pancreatitis can cause reflex distention of bowel which may be misdiagnosed as obstruction.

After thorough examination of the literature there appears to be quite distinct diagnostic patterns for each etiologic cause of large bowel obstruction present concomitantly with the above mentioned common signs and symptoms.

CARCINOMA

Sedgwick (25) and Ulin et al (18) present the typical history of a patient with colon obstruction produced by carcinoma. There is a progressive change in bowel habits over a prolonged period of time, usually with increasing constipation and intermittant diarrhea. In this typical case, which is usually an older adult, there will also be a history of previous bouts of distention, weight loss, easy fatigability, and fever. The patient may have passed blood by rectum and have a very poor appetite. When an older patient presents these complaints and those of intestinal colic, distention and vomiting, the best possibility is carcinoma of the colon with obstruction.

VOLVULUS

Volvulus most commonly occurs in two locations, the sigmoid and cecum. Volvulus is most common in the 40-70 year age group. The acute sigmoid and cecal volvulus are most frequent in the younger age group while the subacute sigmoid volvulus is most frequent in the older age group.

The acute types of volvulus have a short onset with the rapid appearance of signs and symptoms of very sharp crampy abdominal pain localized in the area affected, marked distention of closed loop of colon, nausea and vomiting, and increasing obstipation. There is marked prostration. The affected loop develops gangrene early and the patient runs a fulminating course unless there is surgical intervention immediately.

Hendricks & Griffin (3) describe the subacute type of volvulus as having a gradual onset of symptoms. There is usually a history of previous attacks with relief by repeated enemas. These usually develop gangrene late and run a moderate course.

Volvulus is a condition that must be diagnosed early because of the immediate danger of strangulation and perforation.

DIVERTICULITIS

Diverticulitis presents a chronic picture of repeated attacks of severe pain and with extreme tenderness in the L.L.Q., usually precipitated by eating some coarse food such as nuts or popcorn. These repeated bouts produce edema and inflammation which leads to fibrosis and scarring of the bowel wall. Eventually one of these acute attacks, with its resultant inflammation and edema on the already fibrosed bowel, leads to acute colon obstruction.

ADHESIONS

Becker (26) states that only 1.2% of all obstructive adhesions occur in the large bowel. A history of previous abdominal surgery, peritonitis, or carcinomatous pelvic lesions with the obstructive signs and symptoms listed above should lead one to consider adhesions as the etiologic cause of the obstruction.

HERNIAS

When the surgeon is dealing with an obstruction, he should always check the hernial orifices. The external orifices at which hernia occurs most frequently are the inguinal, femoral, and umbilical in order of frequency. These hernias most commonly give rise to symptoms of strangulation.

INTUSSUSCEPTION

Kahle & Thompson (27) say that intussusception in children presents a more classical disease picture than practically any other disease. A typical history presents a well child which suddenly screams out with pain, becomes pale, and breaks out in perspiration. Intermittant attacks like this follow at a variable interval of time, and the child usually acts apparently normal between attacks. Some infants may lie still between attacks. Vomiting soon follows and there is usually passage of a bloody stool. The temperature and pulse remain normal for a long time. An abdominal mass is palpated in the majority of cases. Stammers (28) states that a small intussusception may lie under the liver and not be felt. He adds that there may not be any blood in the stool when the intussusception is loose and travels easily.

The adult type of intussusception is rarely the acute fulminating type like that of the infant and young child. Its duration is from 3 days-3 years with an average of 8 months. Brayton and Norris (15) have one case in which a barium enema

revealed an intussusception, but 9 months passed before the patient consented to surgery. Becker (29) has concluded from his series that there is no uniformity in the clinical picture in adults or adolescents. Intussusception usually does not present a picture of complete obstruction.

The incidence of intussusception in children is higher in the summer and is more common in males. In Ravitch & McCune's (30) series of children from 1 day-15 years, 61% occurred between 4-11 months of age.

A comparison of the signs and symptoms of intussusception in adults and children is given in Table #5.

	ADULTS	CHILDREN
Vomiting	70%	92.8%
Pain	78%	60.7%
Bloody stool	40%	85%
Palpable mass	57%	85%

TABLE 5

Ravitch & McCune (30) make a few comments on their statistics on the children. First, they believe that the incidence of pain would be higher except that in the history obtained from some of the mothers of affected infants it was difficult to determine whether pain was present or not. Secondly, that 7% of the cases had prolapse of the intussusceptum at the rectum. Therefore one must always do a rectal on these patients.

Recurrence of intussusception is common in adults, but rare in children.

MANAGEMENT

PHYSIOPATHOLOGY

A discussion of the management should be prefaced by a few remarks as the the physiopathology of intestinal obstruction.

The changes in the bowel physiology are related by Haggstrom & Rousselot (31) and Berry (32). Following the onset of sudden obstruction, violent peristalsis takes place proximal to the lesion. Peristalsis in large bowel is of a mass segmental type, occurring at less frequent intervals than small bowel. Therefore, the pain is sudden and severe, but exacerbations tend to be less severe and less frequent. After a prolonged period of time, the bowel fatigues due to hypoxia and paralysis of the bowel follows. This predisposes to distension which acts as a "protective" mechanism, otherwise the intra-luminal pressure would soon surpass the diastolic blood pressure and necrosis, gangrene and perforation would soon result. There is increasing venous congestion with an increased extracellular fluid content. Hypoxia, and eventually anoxia of the capillary wall, also allows for exudation of fluids. The bowel wall becomes very edematous. Fluids begin to pass into the lumen and finally through the serosa into the peritoneal cavity. Bacteria can penetrate the wall of the bowel without perforation. This is a longer process in large bowel obstruction

than when the small bowel is affected. The large bowel is more susceptable to strangulation and perforation because it has a thinner wall and poorer blood supply than the small bowel.

The large bowel is also subject to greater internal pressures because it is usually a closed loop obstruction. Dennis (33) has shown that 61% of ileocecal valves are competent, and even if a valve is incompetent the cecum can still perforate. Sperling (34) has shown that the competent ileocecal valve can withstand intra-luminal pressures up to 50 cm. of water, and bowel at such a pressure will develop necrosis and gangrene. Similar pressures were also found in human beings.

The related physiopathological effect on other systems resulting from obstruction is discussed by Dodd (35) and summarized in Table #6.

I. Respiratory Changes
   A. Distention leads to
      1. Limited diaphragmatic excursion
      2. Higher diaphragmatic resting level, contributes to basal atelectasis
   B. Rigidity (if peritonitis is present) leads to limited inspiratory excursion

   } Asphyxia

II. Electrolyte Changes
   A. Fluid Loss
      1. Vomiting and gastrointestinal drainage
      2. Internal loss without vomiting (into intestinal wall, lumen & peritoneal cavity)

   } Decreased volume of salt water

   B. Water intake during period of vomiting
      1. If patient drank water ⟶ decreased concentration of salt water in body
      2. If patient did not drink water ⟶ increased concentration of salt water in body
      3. If patient intake and output were equal ⟶ concentration would remain the same

C. Site of obstruction
   1. High obstruction ⟶ alkalosis
   2. Low & chronic obstruction may have acidosis

III. Hemodynamic Changes
   A. Distention
      1. Reflex distention of viscus ⟶ shock
      2. Diminished venous return ⟶ shock
   B. Plasma deficit
      Salt water deficit } Hypovolemic shock
   C. Red blood cell loss
      1. Peritonitis
      2. Hemorrhagic infarct
      3. Chronic obstruction

} Shock

IV. Nutritional Change
   A. Acute obstruction leads to glycogen depletion ketosis
      (develops in children 24 hours after cessation of intake)
   B. Chronic obstruction leads to
      1. Hypoproteinemia
      2. Avitaminosis
      3. Anemia

TABLE 6

REPLACEMENT THERAPY

Most authors agree that the surgeon cannot take time for complete replacement therapy before surgical intervention because of the urgency that gangrene be prevented.

These patients should have replacements of 1) electrolytes, 2) water, and 3) blood and plasma pre- and post-operatively. Oxygen should be started as soon as the patient enters the hospital and continued after surgery if necessary. Antibiotics are also given pre- and post-operatively.

There were two interesting experiments in the literature that emphasize the importance of antibiotic therapy in obstruction. Cohn (36) and his group have found in their experiments on dogs

that: 1) bacteria can be removed almost completely from the bowel with the use of oral antibiotics, 2) parenteral penicillin and I. V. aureomycin post-operatively are highly effective in controlling the bacterial flora of peritoneal fluid, 3) blood loss was less in dogs getting antibiotics. They believe that the toxins of Cl. welchii were the cause of death in strangulating obstructions, since Cl. welchii, B. coli, and non-hemolytic streptococcus were the only bacteria uniformly cultured from the peritoneal fluid.

The other experiment by Hawthorne (37) shows the importance of antibiotic therapy. Strangulating obstruction was created artificially in a series of test animals. The results were: 1) if no treatment of any type was instituted, the average survival time was 14 hours; 2) if the animals were intensively treated to prevent shock, electrolyte imbalance, and hemorrhage, (death was due to the absorption of toxic substances from the gut lumen and that absorbed by the blood stream from the exudate in the peritoneal cavity) the average survival time was increased to 36 hours; 3) if the intensive supportive treatment listed in item 2, plus the use of antibiotic, was instituted, the average survival time was increased to 72 hours. The antibiotics used were penicillin, tetracyline, and streptomycin. Hawthorne believes that the antibiotics delay the organisms action on the gut wall.

Blood should be drawn when the patient enters the hospital to use for electrolyte, CO_2 combining power, pH, hemoglobin, white blood count and other necessary determinations, but therapy should be started immediately, determined by the clinical findings. The results will be used post-operatively as a base line for further therapy.

Haggstrom and Rousselot (31) routinely use a long intestinal tube in colon-obstructed patients before and after surgery. Gale (38) suggests the use of the Cantor tube on a trial basis as conservative treatment in two types of colon obstruction. This, he states, gives the surgeon a chance to prepare the patient for surgery both medically and surgically. The use of a tube is suggested in 1) early obstruction with slight colon distention—this prevents the further passage of materials into the large bowel, and 2) colon obstruction with incompetent valve.

DIRECT TREATMENT

GENERAL. A few introductory remarks should be made about right and left sided lesions in the colon since the treatment varies as to which side is involved. The bacterial count on the right side is very much less, and the fluid content of the stool is much greater than the left side. The typical growth on the right is a flat lesion usually on the lateral side, while that on the left is an encircling lesion. The right colon is more fixed than the left.

The objectives in direct treatment of the obstruction are: 1) immediate or delayed decompression of the bowel, 2) partial or complete diversion of the fecal stream, and 3) temporary or permanent colostomy.

Many surgical techniques have been devised for the primary attack on the obstruction. Basically two methods of decompression prevail, which have been the source of greatest controversy in regard to treatment of colon obstruction. These are the cecostomy and the transverse colostomy.

The surgeon must decide whether he is going to attack the lesion primarily or first decompress the bowel and then treat the lesion at later surgery. This depends on the metabolic state of the patient, the duration of the obstruction, the side of the colon on which the lesion is found, and the viability of the bowel. Howard (5) states that although the vast majority of cases of colon obstruction are treated by the two-stage procedure, one may perform a one-stage operation on the right side of the colon without proper bowel preparation, whereas on the left side, one is inviting serious consequences if he tries to do a one-stage procedure without preparation.

Without question, if one is dealing with strangulated bowel or is in doubt as to whether strangulated bowel is present, there is definite indication present for an immediate exploratory operation. Primary resection or exteriorization of necrotic and

gangrenous bowel must be done. If, at surgery, doubt still remains as to viability of the bowel, the surgeon can either resect the affected bowel and leave an associated vent or exteriorize and watch the progress of the bowel for return to normal appearance and function.

ANESTHESIA. The problem of anesthesia in patients with intestinal obstruction is reviewed by Dodd (35). He believes endotracheal anesthesia with a cuffed tube using cyclopropane and/or ether is the procedure of choice. Spinal anesthesia is contra-indicated in the markedly distended patient. Adequate block and infiltration anesthesia is good in poor risk patients.

INTUSSUSCEPTION. The first entity in the discussion of treatment will be intussusception since it can be treated permanently by non-surgical reduction. This applies only to infants and children with intussusception.

Ravitch and McCune (30) have been the chief exponents of hydrostatic barium reduction of intussusception in children. They believe this is the best treatment available, because of the decreased morbidity and mortality.

Their method is to insert a 45 c.c. Foley bag catheter into the rectum and, squeezing the gluteal cheeks together, run barium into the colon at a hydrostatic pressure of three feet and follow the progress radiologically. A maximum of three attempts in reduction are allowed. This is followed by surgery if necessary

to confirm the reduction or complete the reduction if the intussusception persists. This is done through a small McBurney incision.

Their criteria for a successful reduction are: 1) entrance of barium into the small bowel, 2) return of the barium with feces and flatus, 3) disappearance of the mass, 4) clinical improvement of the child who often falls into a natural sleep, and 5) subsequent recovery in the stool of charcoal given by mouth six hours before, or the appearance of a blood-free stool.

Ravitch (39) reports his latest statistics of treatment by this method. He has a total of 65 cases in his series. Fifty cases (77%) were treated by barium reduction alone and 15 (23%) were treated by barium and surgery without any mortalities. In his last 21 cases, 19 (90%) were reduced by barium enema alone.

In his series, if the patient was treated within 36 hours, 1 in 40 had an irreducible bowel to barium and surgery and had to be resected, and 1 in 15 had gangrenous bowel.

Ravitch (30) gives sulfasuxidine orally for several days following the procedure as prophylactic protection against a specific enteritis.

Kahle and Thompson (27) present the surgical treatment of children's intussusception in their article. A tube is passed into the stomach before surgery and is kept there until any

possible chance of vomiting and aspiration has passed. Aspiration of the stomach is routine in all children's surgery.

Ether is the anesthetic of choice. A right rectus or transverse supraumbilical incision is used. Simple reduction of the intussusception is tried for a period of about 10 minutes. If this fails, a resection of the involved segment is done. The mortality in their series has been 8 deaths in 40 simple reductions and 3 deaths in 7 cases in which resection was required. In the past 5½ years they have had only one death in 25 cases, a mortality rate of 4%.

Kahle and Thompson (27) stress two points in the management of these cases. First, don't give more than 10 c.c. of blood per pound of weight at one time; and secondly, that it is not uncommon to have hyperpyrexia for 4-6 days following surgery without apparent cause.

Jones (40) suggests the use of a two-stage procedure for resection of irreducible intussusception instead of primary resection, because of the marked reduction in mortality. In his first stage he exteriorizes the loop with the wall of the abdomen closed snugly around it (no suture attached anywhere). The skin incision is protected, and bowel clamps are applied to the loop and the devitalized bowel is removed. A small Paul's tube is tied into each end of the bowel. The second stage is done about 48 hours later. First, tie stout ligatures around each limb between

Paul's tube and skin. Cut the bowel just ahead of the ligature and remove the two Paul's tubes. Thoroughly cleanse the skin and bowel with citrimide and remove the skin sutures. The surgeons then should rescrub. Then open the wound and free the limbs of the bowel and cut off the friable edges; close the ends with two layers of continuous catgut. Continuity of the bowel is then obtained by a side to side anastomosis of the limbs. No drain is needed unless there is doubt as to the viability of the bowel.

He has had only one death in 9 cases of irreducible intussusception--a mortality of 11%.

Ravitch & McCune's (30) plan of management of irreducible intussusception is similar to this.

Brayton and Norris (15) treat all colon intussusception in adults as malignant. They start antibiotics on patients as soon as they enter the hospital. Their method is to resect the entire intussusception without attempting reduction.

If the intussusception is acute and on the right side, they will try hydrostatic reduction and if successful, they will have 2-3 days for antibiotic bowel preparation and replacement therapy; then they will do a laporotomy and resect the lesion or area producing the intussusception. But acute intussusception of the transverse left colon is best managed by obstructive resection and exteriorization of the entire invagination, or by primary resection and concomitant decompression using a transverse colostomy or cecostomy.

Jacobs (41) strongly supports the manangment of adult intussusception by the method of Brayton and Norris (15). There is no place for permanent non-surgical reduction in treatment of adult intussusception. He states that recent writings tend to regard adult intussusception as a primary surgical emergency which requires prompt surgical intervention and subsequently the mortality has been markedly decreased.

VOLVULUS. In the early acute sigmoid volvulus conservative treatment is recommended by many surgeons. Michel (2) and his group and Becker (8) have used sigmoidoscopic intubation for decompression of the sigmoidal loop in 25 cases with 3 deaths—a 12% mortality. Becker (8) believes the recurrence of sigmoidal volvulus is high enough to justify elective resection with end to end anastomosis. In his series, 30% recurred and 13.3% of the total had a fatal recurrence. Therefore, if the acute volvulus can be decompressed by sigmoidoscopic intubation, the bowel can be prepared for later prophylactic resection.

If detorsion with sigmoidoscope is unsuccessful, Haymond (42) will resect the sigmoid in one or two stages depending on whether the loop is gangrenous. If the loop is gangrenous he resects it, inverts the distal stump and uses the proximal limb for a colostomy. At the second stage of the procedure he does a side to side anastomosis to restore continuity to the colon.

Moore (43) relates that in volvulus of the cecum there is a very high incidence of gangrene, 20% or more. In these cases he does a right hemicolectomy with an oblique end to end anastomosis of the ileum to the transverse colon.

DECOMPRESSION OF NON-STRANGULATING OBSTRUCTION. Which procedure should be used to decompress the bowel, as stated previously, has provoked an ample amount of controversy in the literature, although recently the trend is to greater use of the transverse colostomy. The techniques in performing the various types of decompressive procedures will be discussed briefly first.

Fundamentally there are two types of cecostomy, the tube cecostomy and the exteriorized cecostomy. The cecostomy is done by entering the abdominal cavity through a right McBurney muscle splitting incision about 10 cm. long. The cecum is handled gently and brought up through the incision, incising the lateral peritoneal reflection if necessary. Every precaution is taken to protect the wound and abdominal cavity from spillage. Iodoform dressings are packed around the cecum before it is entered. The bowel can then be decompressed with a #17 needle. In the tube cecostomy, a Pezzer catheter is inserted through a small incision in the cecum and two purse string sutures are placed around it. After the sutures have been placed around the tube, the cecum is returned to the abdominal cavity and sutured to the anterior abdominal wall. The exteriorized cecostomy differs in that the cecum is left out

of the wound and left to decompress through a longitudinal incision in the cecum.

Wolfson & Greenbery (44) have decompressed all colon obstructions by needle decompression of an exteriorized cecum. They place 3 or more #17 needles into the cecum and let it decompress for 48 hours. Then they place a longitudinal incision in the cecum. Gradually the edge of the cecal opening everts, thickens and becomes attached to the skin incision. This can be closed in several weeks following treatment of the lesion producing the obstruction. In 150 cases they had only two deaths—1.2% mortality. The deaths were due to cerebral apoplexy and pulmonary embolism.

In doing a transverse colostomy, a transverse incision to the right of the midline over the transverse colon is made. Dennis (45) emphasizes that a transverse and not a vertical incision is used, because the transverse colon cannot be brought out through a vertical incision. Grasp the ommentum and pull gently until the colon comes out. Place a hemostat through the mesentery and then pass a rubber covered glass rod through this opening. Sometimes the surgeon may have to break adhesions to free up the transverse colon. If the incision is made small enough, no skin sutures are necessary, or several silk sutures may be placed in the skin at the ends of the incision. Place vaseline gauze around the loop and skin to prevent spillage into

the abdominal cavity. The loop can then be decompressed with a #17 needle. A small incision is made and a 28F catheter is placed in the bowel and a purse string suture is placed around it. In 24-48 hours the anterior wall of the loop is divided at right angles to the long axis of the bowel. The glass rod is removed 10-14 days after the lesion producing the obstruction is resected.

Michel (2), Goldstein (46), and Becker (8) decompress the colon by doing an ileotransverse colostomy for right sided obstructive carcinomotous lesions. When the obstruction is in the cecum or ileocecal region they also do a cecostomy if the ileocecal valve is competent. They resect the right side at later surgery.

Rack and Clement (47) prefer the cecostomy for most colon obstructions because: 1) the area most susceptable to perforation is decompressed, 2) the mild bacterial contamination of the peritoneal cavity provides immunity for future surgery, 3) the bowel can be prepared satisfactorily for future surgery with a cecostomy, 4) usually closes spontaneously (tube-cecostomy). Their mortality rate was twice as high with cecostomy as it was for transverse colostomy for lesions past the splenic flexure.

Howard (5) compares the use of a cecostomy or transverse colostomy in decompression of the left sided lesions in Table #7.

TRANSVERSE COLOSTOMY	CECOSTOMY
1. Provides complete decompression.	1. Inadequate
2. Completely diverts fecal stream.	2. Impossible (tube cecostomy)
3. Technically easily performed.	3. Difficult at times

TABLE 7

Albers and Smith (9) had presented a very detailed comparison of cecostomy and transverse colostomy in complete colon obstruction. They compared 34 cases of each technique. So that the cases in the series were as similar as possible, they chose patients in which age, nutrition, degree of anemia, associated diseases, duration and severity of obstruction, and fluid and chemical balance were closely analagous. The average age for those that had a cecostomy was 67 and the average of those that had a transverse colostomy was 68. Over 75% of these patients were very poor risks. The effectiveness in decompression and the mortality in each method are listed in Table #8.

	CECOSTOMY		TRANSVERSE COLOSTOMY	
Satisfactory	16 (53%)		28 (85%)	
Unsatisfactory	10 (33%)		1 (3%)	
Questionable	4		4	
Deaths within 24 hours	4	(Total mortality) ↓	1	(Total mortality) ↓
	34	56%	34	23.5%

TABLE 8

Table #9 lists the effectiveness and the mortality in the two procedures determined with and without the uncontrollable factors found at surgery.

	CASES	MORTALITY	SATISFACTORY DECOMPRESSION
1. Cecostomy--exteriorized type (without tube cecostomy, perforated cecum or sigmoid)	14	36%	64%
2. Transverse colostomy (without perforated cecum or sigmoid)	25	16%	92%
3. Cecostomy--exteriorized type (with perforation of cecum or sigmoid)	8	62.5%	43%
4. Transverse colostomy with perforation of cecum or sigmoid and rectum	9	44%	67%
5. Tube cecostomy, without exteriorization	12	75%	44%

TABLE 9

The causes of death in order of frequency with each technique are listed in Table #10.

CECOSTOMY	TRANSVERSE COLOSTOMY
1. Inadequate decompression	1. Cardiac and pulmonary complications
2. Perforation of cecum	2. Perforated sigmoid with peritonitis
3. Missed diagnosis	3. Renal failure
4. Pulmonary and cardiac complications	4. Missed perforated cecum
5. Chemical imbalance	
6. Perforation of sigmoid	

TABLE 10

The technical errors contributing to death in each procedure are listed in Table #11.

CECOSTOMY	TRANSVERSE COLOSTOMY
1. Inadequate exteriorization of cecum.	1. Inadequate mobilization of colon.
2. Failure to mobilize cecum enough to prevent tearing.	2. Torsion of colon in exteriorization.
3. Inadequate fixation causing retraction and closure of cecostomy.	3. Too tight wound closure, edema and low grade infection.
4. Failure to irrigate cecostomy adequately.	4. Too long delay in opening colostomy.
5. Too long a delay in opening cecum at operation.	5. Removing colostomy support too soon to permit retraction.

TABLE 11

Albers and Smith (9) conclude from a review of their statistics: 1) perforation of the cecum is an absolute indication for exteriorization and cecostomy; (Rack (48), who uses a tube cecostomy for practically all colon obstructions, also exteriorizes a perforated cecum); 2) obstructing lesions of the hepatic flexure and below are best treated with a cecostomy; 3) a transverse colostomy provides decompression as well as complete fecal diversion, which cannot be obtained by cecostomy; 4) the cecostomy tube must be constantly irrigated or it is not successful, therefore the patient must have good nursing care; and 5) the tube cecostomy is inadequate for emergency decompression; the exteriorized cecostomy is better.

The proper management of these colostomies involves: 1) connection of catheter used for the first 24-48 hours to a drainage bottle; 2) irrigation of tubes with 25 c.c. of warm salt and sodium bicarbonate solution every 4-6 hours; 3) giving

warm enemas twice a day; 4) irrigation of colostomy twice a day after catheter removed; and 5) instillation of antibiotic into colostomy. This regime is continued until the abdomen is flat and the colostomy is working well.

COMPLICATIONS

From his series of 170 cases, Gregg (7) lists the complications in the treatment of colon obstruction as: 1) sepsis, peritonitis and shock (all were the consequence of perforated or gangrenous bowel) were responsible for 2/5 of the complications and 1/2 of the deaths; 2) thrombosis and embolism were responsible for 1/4 of the complications and 3 deaths; 3) dehiscence was responsible for 2 cases with no deaths; 4) pneumonia was uncommon, found in only 2%; 5) cardiac and renal failure was surprisingly infrequent considering the age group. One-fourth of the patients developed serious post-operative complications and 1/8 died.

MORTALITY

The mortality rates listed by some authors have been mentioned briefly already, but a few general statements should be added. In Becker's (8) series there was a 70% mortality in primary resection of a carcinoma producing obstruction, while the mortality was only 8% in elective secondary resection. In good risk patients with right sided lesions, primary resection can be done at 1/4 the former mortality rate. The mortality rate is

approximately 15 times greater when perforation and gangrene are present. In Gregg's (7) series there were 6 deaths in 7 cases when gangrene and perforation were present. But in simple obstruction there were only 2 deaths in 46 cases. Goldstein (46) and his group also had a high mortality when perforation was present; 5 deaths in 8 cases.

Most writers agree that the overall mortality for cecostomy is more than twice that for transverse colostomy. This is due mainly to increased incidence of peritonitis and unsuccessful decompression. Dennis (33) reports in his series a 50.0% mortality rate with cecostomy and a 7.9% mortality rate with transverse colostomy.

According to Michel (2) et al and Hendricks and Griffin (3) the statistics show continual decrease in mortality in treatment of colon obstruction through the years. They have shown that mortality has been reduced nearly 100% in the past six years over the preceding six year period.

Hendricks and Griffin (3) list the factors which have caused the decrease in mortality as: 1) earlier diagnosis; 2) earlier decompression; 3) adequate preparation of the patient for surgery; 4) better anesthesia, especially the use of local in the poor risk patients; and 5) the increased use of the transverse colostomy.

DISCUSSION

The problems in the management of a patient with large bowel obstruction are some of the most difficult the surgeon has to face. The diagnosis in some instances may present a real challenge to the surgeon, because many of these patients may not appear or feel very ill. They may complain only of a few gas pains and a little bloating. They probably have had similar episodes before which they have treated successfully at home with repeated enemas, thus they aren't alarmed until acute complete obstruction results. Until then, many patients don't seek the aid of the doctor.

Michel (2) recommends that if the surgeon cannot make a definitive diagnosis, to determine whether intestinal obstruction is present, obtain a barium enema to prove that it is in the large bowel, and then explore the abdomen.

Another quandary is that one is dealing with mainly the old age group with at least 1/3 of them very poor surgical risks. In this age group the problem of an already impaired blood supply is present and further embarrassment by distention enhances possible perforation and strangulation.

Early diagnosis, early improvement of the metabolic state of the patient, and early attack of the cause will result in decreased morbidity and mortality. Procrastination will result in increased mortality.

Which technique should the surgeon use to relieve the obstruction? Many surgeons believe the only treatment for infant intussusception is surgical, but Ravitch's (30) method of hydrostatic reduction has a record much too impressive to forget. He has markedly decreased the morbidity and his mortality is less than that by surgical technique. He states that this technique has been used in this condition in some foreign countries for many years with excellent results. The trend now is toward increased use of this method in certain centers where the condition is diagnosed in the first twenty-four hours.

The placement of the colostomy as near to the point of obstruction as possible seems physiologically and mechanically the most sensible procedure as long as it does not interfere with the secondary surgical procedure. This means doing an exteriorized cecostomy with or without an ileotransverse colostomy for right sided lesions, and a transverse colostomy for left sided lesions. Then the mortality rate and satisfactory decompression rate in each type are more nearly equal. The only authors who had good results doing a cecostomy on all colon obstructions that were found in this review were Wolfson and Greenbery (44). They did a needle decompression of the cecum and then opened the cecal wall in 48 hours (exteriorized cecostomy) for complete diversion of the fecal stream.

As most authors state, although great strides have been made in the last ten years in decreasing the mortality rate in colon obstruction, it is still too high. Cole (20) asserts that the mortality rate should not exceed 15%. The surgeons who have come close to achieving this percentage are those who have followed the principles reviewed in this thesis.

SUMMARY AND CONCLUSIONS

1. The most common causes of large bowel obstruction in order of frequency are carcinoma, volvulus, diverticulitis, adhesions, hernias, fecal impaction, and intussusception.
2. Carcinoma constitutes over 60% of large bowel obstructions.
3. Diagnosis is accomplished by history and physical, rectal, pelvic, sigmoidoscopic, and x-ray examinations.
4. Large bowel obstruction is managed primarily by a two-stage operation--primary decompression and secondary excision of the lesion.
5. Right sided obstruction is best decompressed by ileotransverse colostomy and/or exteriorized cecostomy, while left sided obstruction is best decompressed by transverse colostomy.
6. Morbidity and mortality are decreased by early diagnosis, adequate replacement therapy, better anesthesia, and early decompression by the most feasible procedure.

BIBLIOGRAPHY

1. Christopher, Frederick. A Textbook of Surgery. Fifth Edition. Philadelphia, Saunders, 1949. p. 1048.

2. Michel, Marshall Jr., and others: Acute Obstruction of the Colon. Ann. Surg. 139:6 806-15 (June) 1954.

3. Hendricks, William and Griffin, William D.: Intestinal Obstruction. Surg. Clin. of N. America 27:1 51-72. 1947.

4. Anglem, Thomas J. and Kenworthy, Roger A.: Acute Obstruction of the Left Colon. Am. Surgeon 19:2 1162-6 (Dec.) 1953.

5. Howard, Martin A.: Management of Acute Colonic Obstruction. Am. J. Surg. 87:5 740-6 (May) 1954.

6. Torell, Lars: The Treatment of Acute Intestinal Obstruction. Acta Chir. Scand. 189:1-36. 1954.

7. Gregg, Robert O.: Survey of Intestinal Obstruction. Surgery 33:4 506-12 (April) 1953.

8. Becker, Walter F.: Acute Obstruction of the Colon. Surg. Gyn. Obst. 96:6 677-82 (June) 1953.

9. Albers, John H. and Smith, Louis L.: A Comparison of Cecostomy & Transverse Colostomy in Complete Colon Obstruction. Surg. Gyn. Obst. 95:4 410-15 (Oct.) 1952.

10. Gerwig, W. H. Jr.: Volvulus of Colon. A.M.A. Arch. Surg. 60:721-742. 1950.

11. Buenger, Richard: Volvulus of the Splenic Flexure of the Colon. Am. J. Roentg. 71:1 81-3 (Jan.) 1954.

12. Russell, J. Y. W.: Volvulus of the Cecum with Rupture During Labor. J. Obst. Gyn. Brit. Empire 60:4 515-8 (Aug.) 1953.

13. Nelson, Waldo E. Textbook of Pediatrics. Fifth Edition. Philadelphia, Saunders, 1950. p. 824.

14. Deterling, Ralph Jr.; O'Malley, Robert D. and Knox, William: Intussusception in the Adult, with Emphasis on Retrograde Type. A.M.A. Arch. Surg. 67:6 854-64 (Dec.) 1953.

15. Brayton, Donald and Norris, William J.: Intussusception in Adults. Am. J. Surg. 88:1 32-43 (July) 1954.

16. Cowart, G. Thomas and Fort, Chester A.: Intestinal Obstruction as a Complication of Uterosigmoidostomy. Am. Surgeon 19:12 (Dec.) 1953.

17. Cleland, Gavin: Caecocolic Intussusception Following Appendectomy. Brit. J. Surg. 41:165 108-109. (July) 1953.

18. Ulin, Alex W. et al: Diagnostic and Theraputic Problems in Large Bowel Obstruction Due to Carcinoma of the Colon. Pennsylvania M. J. 53:12 1290-94 (Dec.) 1950.

19. Wangensteen, Owen H. Intestinal Obstructions. Second Edition. Springfield, Thomas, 1942.

20. Cole, Warren H.: Intestinal Obstruction. J. Iowa M. Soc. 44:2 (Feb.) 1954.

21. Culligan, Leo: Bowel Obstructions Occurring During the Postoperative Period. Minnesota M. 37:3 198-202 (March) 1954.

22. Miller, J. E.: Roentgen Manifestation of Intestinal Obstruction. Mississippi Doctor 30:5 127-31 (Oct.) 1952.

23. Sante, L. R.: Intestinal Obstruction, Paralytic Ileus, Mesenteric Thrombosis and Kindred Lesions. J. Missouri M. A. 48:11 889-895 (Nov.) 1951.

24. Laufman, Harold: Intestinal Strangulation Obstruction. Rev. Gastroenter. 19:10 817-25 (Oct.) 1952.

25. Sedgwick, Cornelius: Intestinal Obstruction in the Aged. Surg. Clin. of N. America 34:3 729-735 (June) 1954.

26. Becker, Walter: Acute Adhesive Ileus. Surg. Gyn. Obst. 95:4 472-6 (Oct.) 1952.

27. Kahle, Richard and Thompson, Clarence: Diagnostic and Theraputic Considerations of Intussusception. Surg. Gyn. Obst. 97:6 693-701 (Dec.) 1953.

28. Stammers, F. A. R.: The Management of Intestinal Obstruction. Ann. R. Coll. Surgeons England 9:189-202. 1951.

29. Becker, Walter F.: Acute Intussusception in Adolescents and Adults. J. Louisiana M. Soc. 105:3 110-114 (March) 1953.

30. Ravitch, Mark M. and McCune, Robert M. Jr.: Intussusception in Infants and Children. J. Pediat. 37:2 153-173 (Aug.) 1950.

31. Haggstrom, Gustave and Rousselot, Louis M.: Acute Intestinal Obstruction. Surg. Clin. of N. America 30:479-494. 1950.

32. Berry, Robert E. L.: Diagnosis and Treatment of Acute Intestinal Obstruction. J. Am. M. Ass. 148:5 347-355 (Feb.) 1952.

33. Dennis, Clarence: Treatment of Large Bowel Obstruction; Transverse Colostomy--Incidence of Incompetency of Ileocecal Valve. Experience at University of Minnesota Hospital. Surgery 15:713 (May) 1944.

34. Sperling, L.: Role of Ileocecal Sphincter in Cases of Obstruction of Large Bowel. A.M.A. Arch. Surg. 32:22 (Jan.) 1936.

35. Dodd, Robert B.: Problems in Anesthesia for Intestinal Obstruction. South M. J. 45:9 805-810 (Sept.) 1952.

36. Cohn, Isidore; Gelb, Albert and Hawthorne, Herbert: Strangulation Obstruction--The Effect of Pre- and Post-Operative Antibacterial Agents. Ann. Surg. 138:5 748-52 (Nov.) 1953.

37. Hawthorne, Herbert R.: Recent Advance in the Management of Intestinal Obstruction. Pennsylvania M. J. 56:3 284-86 (March) 1953.

38. Gale, Charles: Intubation, Enterostomy and Laparotomy: Their Place in the Treatment of Intestinal Obstruction. M. J. Australia 1:9 317-339 (March) 1951.

39. Ravitch, Mark M.: Reduction of Intussusception by Barium Enema. Surg. Gyn. Obst. 99:4 431-435 (Oct.) 1954.

40. Jones, J. D. T.: Treatment of Irreducible Intussusception. Brit. M. J. No. 4849:1304-6 (Dec.) 1953.

41. Jacobs, W. Francis: Intussusception. Illinois M. J. 103:4 250-5 (April) 1953.

42. Haymond, H. E.: Volvulus of the Sigmoid Colon. Rocky Mountain M. J. 51:3 194-201 (March) 1954.

43. Moore, Thomas C.: Acute Spontaneous Volvulus of the Right Colon with Gangrene. J. Indiana M. Ass. 47:3 237-40 (March) 1954.

44. Wolfson, William L. and Greenbery, Morris W.: Needle Decompression and Temporary Cecostomy for Severe Colon Obstruction. J. Internat. Coll. Surgeons 20:5 579-85 (Nov.) 1953.

45. Dennis, Clarence: Acute Intestinal Obstruction. Surg. Clin. of N. America 29:2 1397-1420 (Oct.) 1949.

46. Goldstein, Morton S. et al: Intestinal Obstruction in the Aged. J. Am. Geriat. Soc. 1:3 205-12. 1953.

47. Rack, Frank and Clement, Kenneth W.: Cecostomy and Colostomy in Acute Colon Obstructions. J. Am. M. Ass. 154:4 307-9 (Jan.) 1954.

48. Rack, Frank J.: Obstructive Perforation of the Cecum. Am. J. Surg. 84:5 527-33 (Nov.) 1952.