INTESTINAL OBSTRUCTION IN THE NEWBORN*

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THE problem of intestinal obstruction in the newborn period, i.e., in the first 30 days of life, still presents a great challenge to both the pediatrician and the surgeon. Although a great deal has been accomplished in the treatment of obstruction in recent years, the mortality of this condition in the newborn infant would still appear to be inordinately high. We have reported our experiences previously[1] in an attempt to analyze critically the problem of diagnosis, the factors which affect the prognosis; the causes of death and the follow-up results in this age group.

The present report is based on 207 consecutive cases of neonatal obstruction that were seen at Babies Hospital, New York City, from 1939 through 1955. In each case the diagnosis was confirmed at operation or at autopsy. The study includes cases of obstruction of the small intestine and colon. It does not include obstructions of the esophagus, stomach and rectum. Neonatal obstructions of the rectum have been reported elsewhere.[2]

This presentation gives a brief account of these 207 cases. Comprehensive discussions of the various conditions can be found in the reports of many authors.[3-22] Emphasis will be given to the factors affecting the prognosis, the causes of death and the follow-up results. Because of the recent pediatric and surgical interest in meconium ileus and congenital megacolon in the newborn period, special attention will be given to these conditions.

DIAGNOSIS

It has often been said that "to treat an infant as a small edition of an adult is to invite disaster." This admonition is certainly borne out

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in the subject under consideration. Although the significance of such symptoms as vomiting and abdominal distention have the same importance in the adult as in the newborn infant in directing the physician's attention to obstruction, it must be emphasized that the infant has a small reserve in any acute illness and that the physiologic disturbances associated with obstruction are much more acute and often fulminating in this age group.[23,24] Hence, early diagnosis is of paramount significance and actually becomes the most important single factor in the prognosis.

Early diagnosis is merely a matter of acute awareness of the problem in the newborn period. Many lives could be saved if one followed the simple dictum that any newborn who vomits, especially if he vomits bile, or shows abdominal distention, is suspect and deserves plain 3-position x-rays of the abdomen without delay. The diagnosis is especially treacherous in the premature infant who may show very little or no clinical evidence of peritoneal reaction even in the presence of a closed loop obstruction or peritonitis. It is easy to err on both sides in the premature infant, i.e., missing the diagnosis of obstruction or operating in the absence of actual obstruction. Certainly, the most important single diagnostic measure is the plain x-ray using the conventional 3 positions. Rarely, is contrast medium needed and, indeed, it should be avoided in the usual case.

Etiology

An outline of the causes of obstruction which we find useful in classifying our lesions is shown in Table I. Tables II and III present the frequency of the various lesions, the results and follow-up data of the present series. It should be emphasized that the material includes only those cases of obstruction which were admitted to the Babies Hospital in the newborn period.

Atresia and Stenosis

These intrinsic obstructions comprised over one-quarter of the total. This distribution of the lesions and results are shown in Table IV. Atresia and stenosis of the colon, exclusive of the rectum, are rare. More than one site of atresia was found in five of 38 cases. In two of these, there were 12 points of atresia. This corresponds to the incidence of 15 per cent of multiple atresias reported by others.[25]

TABLE I.—CAUSES OF INTESTINAL OBSTRUCTION IN THE NEWBORN INFANT

I. *Mechanical*
- A. Congenital
  - 1. Intrinsic
    - a. Atresia and stenosis
    - b. Meconium ileus
    - c. Hypertrophic pyloric stenosis
    - d. Meconium "plug"
  - 2. Extrinsic
    - a. Malrotation with or without midgut volvulus
    - b. Volvulus without malrotation (local volvulus)
    - c. Congenital peritoneal bands
    - d. Incarcerated hernia- inguinal, internal, diaphragmatic
    - e. Annular pancreas
- B. Acquired
  - 1. Intussusception
  - 2. Peritoneal adhesions
    - a. Following surgery
    - b. Following peritonitis

II. *Neurogenic*
- A. Defective intrinsic innervation (aganglionosis)
  - 1. Colon and rectum—congenital megacolon
  - 2. Small intestine
- B. Paralytic ileus
  - 1. Cerebral injury
  - 2. Infection

Causes of the high mortality are discussed later. The follow-up period for the 24 survivors has been three months to 9⅓ years. In 21, the follow-up data is complete (followed to the present time). In two, the follow-up was incomplete but adequate. These were operated upon 11 and six years ago and were last seen six and 3½ years later, respectively. One patient who had an excellent result one year following her operation 13 years ago, has not been seen since.

The youngest survivor, now three months old, required a tracheostomy because of postoperative laryngeal obstruction but is in excellent condition. Another patient had three operations because of breakdown of the anastomosis but is now well 16 months following the

TABLE. II.—INTESTINAL OBSTRUCTION IN THE NEWBORN INFANT (BABIES HOSPITAL 1939-1955)

Cause	*No. of Cases*	*Recovered*	*Died*	*Mortality (%)*
Atresia and stenosis	57	24	33	58
Meconium ileus	37	12	25	67.5
Malrotation	30	25	5	16.6
Aganglionosis	28	20	8	28.8
Inguinal hernia	14	14	0	
Congenital peritoneal bands	12	8	4	
Local volvulus	10	5	5	
Adhesions, postoperative	2	2	0	
meconium peritonitis (cause undetermined)	6	2	4	
Internal hernia	3	2	1	
Intussusception	3	1	2	
Annular pancreas	1	1	0	
Meconium "plug"	1	1	0	
Multiple causes	3	3	0	
TOTAL	207	120	87	42

TABLE III.—STUDY OF 207 CASES

Deaths			87
Autopsies done in	81		
Recoveries			120
Lost to Follow-Up	8	(6.6%)	
Adequate Follow-Up	112	(93.4%)	
Complete Follow-Up (to date of present report)	96	(80%)	

last operation. A third patient died four months later from surgery related to a neuroblastoma but had been relieved of a duodenal obstruction in the first week of life. All of the others are in excellent condition, without symptoms referable to their lesion or to the surgery.

TABLE IV.—ATRESIA AND STENOSIS

Site	*No.*	*Recoveries*	*Deaths*
Atresia			
Duodenum	11	5	6
Jejunum	5	1	4
Ileum	16	7	9
Colon	1	1	0
Multiple	5	0	5
TOTAL	38	14	24 (63%)
Stenosis			
Duodenum	10	6	4
Jejunum	2	0	2
Ileum	5	3	2
Colon	2	1	1
TOTAL	19	10	9 (47%)
Total number of atresia and stenosis	57	24	33 (58%)

MALROTATION

In this group of 207 cases of intestinal obstruction in the newborn infant only 30 were due to malrotation. Although many other cases were seen after this thirty-day period, they are not included in this study.

Anomalies of rotation gave rise to intestinal obstruction in two ways in this small series:

1. Most commonly the obstruction was due to volvulus of the midgut loop. This portion of intestine includes the jejunum, ileum, and large intestine up to the middle of the transverse colon, i.e., the segment supplied by the superior mesenteric artery. Failure of fixation of the mesentery, the short primitive duodenocolic isthmus, and the narrow pedicle of the mesentery allow the entire midgut loop to twist around its limited attachment resulting in obstruction of the duodenum. It occurred in 27 of our 30 cases (Table V). The volvulus was always in the clockwise direction and torsions of 180 degrees to four complete turns were seen. The tightness of the volvulus rather than the number of turns determined the severity of the symptoms.

TABLE V.—MALROTATION WITH NEONATAL OBSTRUCTION

Number of Cases		30
With volvulus of midgut	27	
Without volvulus	3	
With associated peritoneal bands	16	
Cases with gangrene	5	
OPERATIVE PROCEDURES		
Number of Cases		30
Reduction with cecopexy	13	
Reduction with division of peritoneal bands (Ladd's operation)	12	
Division of peritoneal bands (no volvulus)	3	
Resection and anastomosis	2	
Recurrence of volvulus	1	
Deaths	5	(16.6%)

The picture was usually that of incomplete duodenal obstruction with intermittent vomiting of copious amounts of bile-stained fluid.

Since the superior mesenteric vessels form the pedicle around which the volvulus occurs, there may be obstruction of the vascular supply to the intestine. The symptoms and signs of strangulation obstruction ("blue-bowel syndrome") are then added to those of simple obstruction. In some cases, the passage of blood by rectum was the first sign. With complete occlusion of the vessels, gangrene of the entire midgut may occur. This was seen in three of our cases. In two patients, gangrene of a limited segment of intestine occurred and resection was possible.

2. Less frequently, the obstruction was due to incomplete rotation of the cecum, without volvulus of the midgut. This was found in three cases (Table V). The cecum lies in the upper abdomen and there are congenital peritoneal bands associated with this malposition. These broad bands course from the cecum or the transverse colon over the descending part of the duodenum and are attached to the undersurface of the liver or to the posterior abdominal wall in the right upper quadrant of the abdomen giving rise to partial duodenal obstruction. Sometimes the obstruction is due to pressure from the overlying cecum itself.

Reduction with cecopexy (attaching the cecum in the right lower quadrant of the abdomen) was done in 13 cases. This procedure has always been strongly advocated by Donovan[26] as a safeguard against recurrent volvulus since it gives a wider base of attachment to the midgut segment. Ladd's procedure of dividing all of the congenital peritoneal bands thereby freeing the duodenum and allowing the cecum to lie in the left side of the abdomen was carried out in 12 of the cases.

The follow-up period for the 25 survivors was two months to 12 years. Five of the patients required operation for intestinal obstruction due to postoperative adhesions.

The follow-up is complete in 23 of the cases. They are asymptomatic. Two of the patients who were operated upon 15 and 16 years ago were free of symptoms when last seen eighteen months and two months respectively after operation.

Meconium Ileus

According to the recent studies of di Sant'Agnese[27] about 10 per cent of patients with fibrocystic disease of the pancreas seen at the Babies Hospital also presented intestinal obstruction in the newborn period. The ileus is due to an abnormal meconium which becomes inspissated in the lower ileum and blocks the lumen of the intestine. This is considered to be the earliest and severest manifestation of a generalized disease which is hereditary and in which probably all of the exocrine glands are affected.

The characteristic picture is one of hypertrophy and dilatation of the mid-ileum which contains semi-fluid and tenacious meconium. The distal 10 to 20 cm. of ileum are filled with hard, gray concretions resembling dry putty. The large intestine is usually empty, small and hypoplastic.

In 1938 Andersen[28] recorded the first complete description of the disease and noted the association of meconium ileus with cystic fibrosis of the pancreas. In 1944 Farber[29] related the deficient pancreatic enzymes to the abnormal meconium. In 1942 Hurwitt and Arnheim[30] reviewed the literature and were unable to find any instance of recovery. In 1948 Hiatt and Wilson,[31] of this institution, described a new method of treatment and reported the first successfully treated cases. In 1952 Gross[4] reported on a remarkable series of 19 cases treated by a Mikulicz type of resection and double ileostomy with

TABLE VI.—MECONIUM ILEUS PREOPERATIVE DIAGNOSIS

Meconium ileus	15
Atresia of intestine	11
Volvulus	4
Intussusception	1
Intestinal obstruction-? cause	6
	37

TABLE VII.—MECONIUM ILEUS ASSOCIATED PATHOLOGY

Total Number of Cases		37
Cases with Associated Intestinal Pathology		23*
Volvulus of small intestine	16	
Congenital peritoneal bands	4	
Malrotation	3	
Meconium peritonitis (3 with "cyst" of intestine)	7	

* More than one lesion in some cases

TABLE VIII.—MECONIUM ILEUS RESULTS OF SURGICAL TREATMENT

Type of Operation	*Cases*	*Operative Deaths*	*Relieved of obstruction*
Removal of meconium through ileotomy	10	7	3
Removal of meconium through ileotomy, reduction of volvulus	6	2	4
Removal of meconium, resection of volvulus, anastomosis	4	1	3
Removal of meconium through ileotomy, ileo-colostomy	1	1	0
Double ileostomy (Mikulicz)	3	3	0
Resection of volvulus, double ileostomy	4	4	0
Resection of volvulus, anastomosis	1	1	0
Reduction of volvulus (only)	2	2	0
Ileo-colostomy (only)	2	2	0
Manipulation of intestine	2	1	1
Division of peritoneal bands	2	1	1
TOTAL	37	25	12

TABLE IX.—SUMMARY OF RESULTS—MECONIUM ILEUS

Total (Surgery for neonatal obstruction, Babies Hospital 1939-1955)		37
Operative Deaths	25	
Relieved of obstruction by operation	12 (32%)	
*Died later of:		
pulmonary infection	7	
malnutrition and dehydration	1	
Living (January 1956)	4 (11%)	

* 3 in first year, 2 in third year, 2 in fourth year, 1 in ninth year

TABLE X.—MECONIUM ILEUS SURVIVORS (JANUARY 1956)

Patient	*Year*	*Operation*	*Maximal Follow-Up*	*Follow-Up*	*Recent X-Ray Chest*
J.M.	1947	Ileotomy, removal meconium	8½ Yrs.	Admitted B.H. at 6 yrs. for Fever ? cause 8 Years—Excellent	normal
P.M.	1953	Resection volvulus, removal meconium, anastomosis	2¾ Yrs.	Admitted B.H. at 1 yr. for Inguinal hernia 2¾ Years—Excellent	normal
M.D.	1953	Reduction volvulus, removal meconium	2¾ Yrs.	Admitted B.H. at 9 Mos. for Inguinal hernia 2½ Years—Excellent	normal
C.C.	1953	Resection volvulus, removal meconium, anastomosis	2⅛ Yrs.	10 Admissions to B.H. up to 2 years, 3 for obstruction due to adhesions, 7 for pulmonary infection 2⅛ Years—Fair	severe changes

relief of obstruction in 15 of the cases (79 per cent).

The preoperative diagnosis, associated pathology and the results of surgical treatment in our series of 37 cases are shown in Tables VI, VII and VIII. It should be noted that volvulus of the small intestine and other lesions were found in association with meconium ileus in a high percentage of the cases. It is essential that the surgeon recognize the pathology of meconium ileus as the cause of obstruction.

In our small group of cases the results have been poor. The obstruction has been extremely difficult to treat and management of the pulmonary complications has been discouraging. Our follow-up studies

are comparable to those of Schwachman and Leubner[32] in that all who survive surgery for the obstruction develop the classical picture of mucoviscidosis with evidence of generalized disease. The eventual outcome generally depends on the severity of pulmonary involvement and the success of controlling the respiratory disease with antibiotics. Twelve of the patients were relieved of obstruction but eight of these subsequently died. The results of our cases and the follow-up data of the four present survivors are summarized in Tables IX and X.

Congenital Megacolon

Swenson and Bill[33] and Hiatt[34] have demonstrated that the basic pathologic physiology in congenital megacolon, or Hirschsprung's disease, is a lack of propulsive movements of the rectum and lower sigmoid colon. This is due to congenital absence, or marked

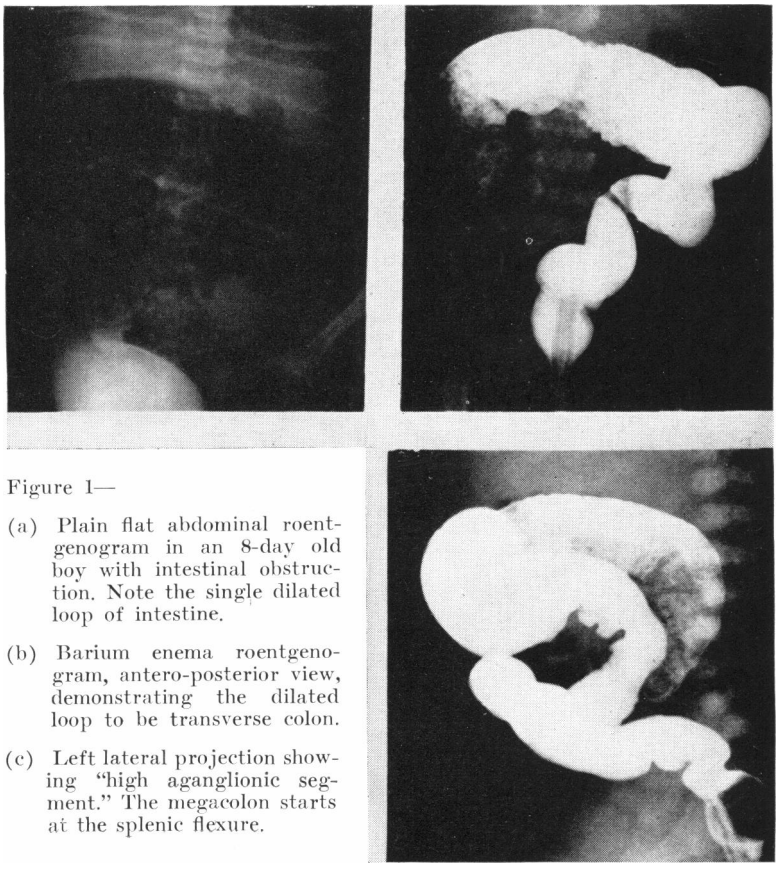

Figure 1—

(a) Plain flat abdominal roentgenogram in an 8-day old boy with intestinal obstruction. Note the single dilated loop of intestine.

(b) Barium enema roentgenogram, antero-posterior view, demonstrating the dilated loop to be transverse colon.

(c) Left lateral projection showing "high aganglionic segment." The megacolon starts at the splenic flexure.

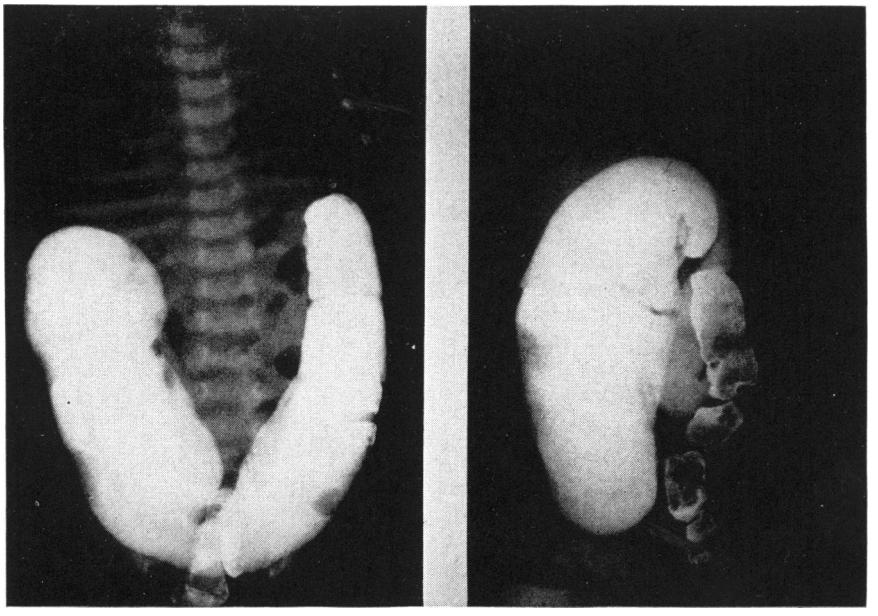

Figure 2—Roentgenograms of a 4 weeks old boy who was admitted following the administration of a barium enema at another hospital. In the lateral projection the megacolon can be seen to start in the upper descending colon.

diminution, of the ganglionic cells of Auerbach's plexus. Zuelzer and Wilson[35] have proposed calling this condition "agenesis of the myenteric plexus" and recently the term "aganglionosis" has been applied to the lesion.

There were 28 cases of intestinal obstruction due to congenital megacolon that were admitted to the Babies Hospital in the newborn period. Although the differential diagnosis between this form of obstruction and ileal obstruction is often difficult, the disease is being recognized with greater frequency in the newborn period than heretofore. As Swenson[36] has emphasized, the barium enema will easily distinguish between the two conditions and probably should be done preoperatively in all cases of intestinal obstruction in the newborn infant (Fig. 1).

The characteristic roentgen findings of megacolon above the level of aganglionosis are not clearly developed until later on, in the usual case. However, we have seen the typical features clearly demonstrated roentgenologically in the newborn period in some of our more severe cases. These may have "high segments" of aganglionosis and the mega-

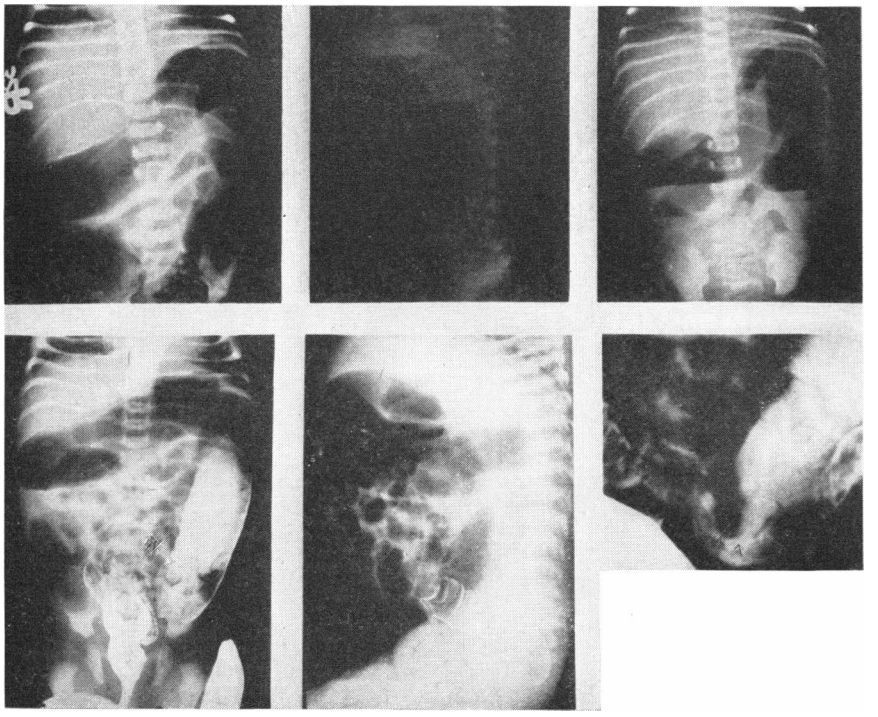

Figure 3—The upper 3 plain roentgenograms of the abdomen in the supine, erect lateral and erect antero-posterior projections were taken in a 3-day old infant and demonstrated intestinal obstruction.

The lower 3 roentgenograms, after the administration of barium by rectum, show the megacolon with the transition area in the upper sigmoid colon at 4 days of age.

colon is found in the descending colon or splenic flexure (Figs. 1, 2 and 3).

It had been our practice to treat these patients conservatively, relieving the obstruction by means of enemas and thereby avoiding colostomy whenever possible. However, from a study of our past cases and the author's more recent experience it seems wiser to advise colostomy more promptly for the newborn infant who is admitted to the hospital because of intestinal obstruction due to congenital megacolon. These are apt to be the more severe cases and conservative management may be difficult and uncertain. Colostomy is usually well tolerated. The definitive procedure of resection and "pull-through" is done at about one year of age. Table XI gives a summary of our group of cases. It should again be emphasized that this discussion concerns only those

TABLE XI.—CONGENITAL MEGACOLON

Admitted to hospital in newborn period because of obstruction			28
Responded to conservative treatment		15	
Required operation (in newborn period)		13	
Survivals			20
No operation to date (5 to 14 months)		3	
Operation performed in		17	
Resection and pull-through	15		
Colostomy (awaiting resection)	2		
Deaths			8

TABLE XII.—MEGACOLON DEATHS (8 of 28 Cases)

Onset	*Age on Admission*	*Age at Operation*	*Operation*	*Autopsy*
1. 1 day	1 day	6 days	Sigmoid colostomy	Pseudomembranous colitis (6 hours)
2. 1 day	2 days	5 days	Transverse colostomy	Anasarca, Hypoproteinemia (5 weeks)
3. 2 days	4 weeks	4 weeks	Sigmoid colostomy	Bacteremia, Anasarca, Hypoproteinemia (2 days)
4. 2 days	2 days	4 days	Transverse colostomy	Perforation of colon proximal to colostomy ? Due to irrigation catheter (4 weeks)
		2 weeks	Resection jejunum for obstruction and gangrene due to adhesions	
5. 1 day	4 weeks	.....	None Died following enema	Rupture of sigmoid colon, barium peritonitis, chronic entero-colitis (5 hours after enema)
6. 1 day	3 weeks	.....	None	
	10 weeks	10 weeks	Transverse colostomy	Acute membranous colitis and ileitis, bacteremia (24 hours)
7. 4 days	4 days	15 days	Transverse colostomy	
		19 months	Resection and pull-through, closure of colostomy	
		23 months	Resection jejunum for volvulus due to adhesions	
		3 years	None	Acute membranous colitis, extreme—Bacteremia, anal stricture (2 days)
8. 2 wks.	4 weeks	.....	None (unrecognized)	Acute membranous colitis (7 days)

cases of congenital megacolon which were admitted to the hospital because of obstruction in the newborn period. Cases which were seen after the neonatal period are not included in this study.

Table XII illustrates the pertinent features of the eight deaths in our group of 28 cases. Acute colitis was found at autopsy in four of the cases; chronic entero-colitis in another. Pseudomembranous colitis has been a serious complication in our experience with megacolon. One of the most severe cases was seen in a six day old boy who died six hours following colostomy (Case 1). The complication is a distressing one and will form the subject of another paper.

Other Causes of Obstruction

The other less common causes of obstruction in the newborn period are also listed in Table II. They are presented in detail elsewhere[1] and will not be discussed here. However, the following observations can be made:

Incarceration or strangulation can be a serious complication of inguinal hernia in the newborn. Of the 14 obstructed hernias, three showed strangulation of the intestine in addition to incarceration. A complication of incarcerated inguinal hernia in this age group which is not stressed sufficiently is gangrene of the testis. It was found in three of our cases and led to atrophy of the organ. The follow-up period in this group is from two months to 11 years. All patients are well, without recurrence.

Twelve of our cases of obstruction were due to congenital peritoneal bands; eight survived. One patient died at home four months after operation probably from obstruction due to adhesions. A second patient developed obstruction from adhesions four months after operation and was relieved by surgery. He has been well for 18 months. The other survivors are asymptomatic and have been followed for: six months, seven, nine, nine, 12 and 15 years.

There were ten cases of local volvulus causing obstruction. The volvulus was confined to a segment of the small intestine. In none of these cases was there associated malrotation, peritoneal bands, meconium ileus or other pathology that was responsible for the volvulus. Nine of them had gangrene and required resection. In eight cases the volvulus was of the fetal type, i.e., occurring in utero. As a result of necrosis of the base of the volvulus in the prenatal period we have encountered

two or four open or, at times, blind ends of bowel with all of the intestinal loops agglutinated in an adhesive or calcified peritonitis. These are complicated cases which test the ingenuity and patience of the surgeon. The five survivors have been followed from eight to 28 months. They are all well.

The two cases due to postoperative adhesions followed abdominoperineal repair of imperforate anus and abdominal repair of a diaphragmatic hernia. Both have been asymptomatic for over four years.

There were six cases of meconium peritonitis with obstruction in which the cause could not be determined either at operation or autopsy. The two survivors have been well for 18 months and eight years.

The three cases of obstruction due to internal herniae were paraduodenal, mesenteric defect and a defect in the falciform ligament. There were two survivors. One was seen two months following operation 10 years ago and the other only one month after operation seven months ago. Both have since been "lost" to follow-up study.

The one survivor of the intussusception group has been well three years postoperatively.

The patient with duodenal obstruction due to annular pancreas was successfully treated by duodenojejunostomy. He was mongoloid and died of pneumonia six months later.

Obstruction due to meconium "plug" was actually seen in three cases. However, in two of these the underlying cause was congenital megacolon and they are considered in that group. The one case listed in Table II was relieved of his plug and obstruction by enemas. He has been followed for six years and is perfectly normal. Clatworthy and his associates[37] have recently reported on this syndrome.

The three patients with obstruction due to multiple causes have been well for four, five and seven years since operation.

Causes of Death

Postmortem examinations were done in 81 of the 87 deaths (93 per cent). Study of the autopsy findings and of the postoperative complications revealed the following factors to be responsible for the high mortality in this group of cases:

1. *Prematurity and associated anomalies:* The incidence of prematurity (under 2500 gms.) was 17.4 per cent. It was found in 35 per cent of the atresia and stenosis group. About 20 per cent of the cases

had other associated anomalies but less than half of these were considered serious or life-threatening.

2. *Shock, dehydration, electrolyte imbalance and nutritional disturbances:* Prolonged anesthesia and surgery, non-functioning anastomoses and break-down of the anastomoses necessitating prolonged gastrointestinal suction were responsible for these complications. Although it has been difficult to properly evaluate the role of any of these factors in a given mortality, each has been the actual basis for the final and more easily defined complication which led to death.

3. *Over-hydration:* Several of the deaths, especially in the premature, were due to pulmonary edema probably resulting from the parenteral administration of excessive amounts of water and salt.

4. *Peritonitis was a common cause of death:* It occurred from leakage at suture lines or from failure to recognize and resect nonviable bowel at the time of operation.

5. *Aspiration of vomitus:* This was a common finding and could often be related to inadequate decompression of the gastrointestinal tract.

6. *Pathology incompatible with life:* As one would expect when dealing with anomalies, some of the conditions found were impossible to treat. Also, heroic efforts were made in some very small premature babies when the chances of salvage were almost nil.

7. *Delay in diagnosis and operation:* This was responsible for an indeterminate number of deaths. The delay was due to indecision on the part of the surgeon or to the late appearance of the patient for treatment.

Discussion

The mortality for the entire group of obstructions was 42 per cent. In recent years it has been lowered from 60 per cent to about 30 per cent in spite of an increasing number of premature infants that are being admitted for treatment from our premature nursery. This improvement in results can be attributed to: a better understanding of the pathology and pathologic-physiology of the lesions, improvement in supportive treatment, the principle of keeping these patients "on the dry side", the improvement in pediatric anesthesia, judicious use of the antibiotics, adequate but not prolonged period of preoperative preparation realizing that a point of "diminishing returns" is reached after a few

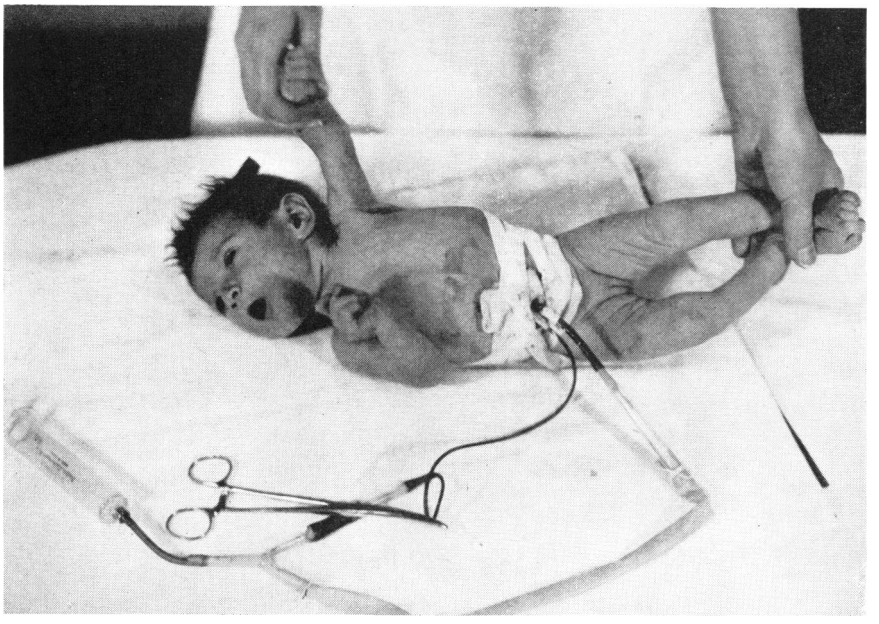

Figure 4—Photograph of 7-day old girl who was operated upon at 1-day for intestinal obstruction due to local volvulus and gangrene which required resection of about 40% of the proximal small intestine. A double enterostomy was performed. Note the catheter and soft rubber tubing attached to the enterostomies. By means of the attached syringe, the proximal bowel contents were effectively delivered into the distal bowel for 7 days. She required only 3 clyses during this period. The double enterostomy was closed by an anastomosis at 7 days of age.

hours, improved care of the premature infant, and a trend towards earlier recognition of obstruction. In my opinion, one of the most important factors in lowering the mortality is the routine use of adequate decompression of the gastrointestinal tract. This is especially true in cases that require anastomosis. The common denominator in many of the postoperative deaths is leakage at the suture line and this is directly or, more often, indirectly responsible for the mortality. For this reason, I believe that fewer primary anastomoses should be done and that they should be done only under ideal circumstances. If they are done, then a catheter type of enterostomy proximal to the suture line is added as this is the best means of decompression in these circumstances. Decompression of the stomach by means of a nasogastric tube is usually inadequate. In many circumstances, double enterostomy is a good method of treatment and should be used more often. Crushing of the spur of the double enterostomy with anastomosis or actual delayed

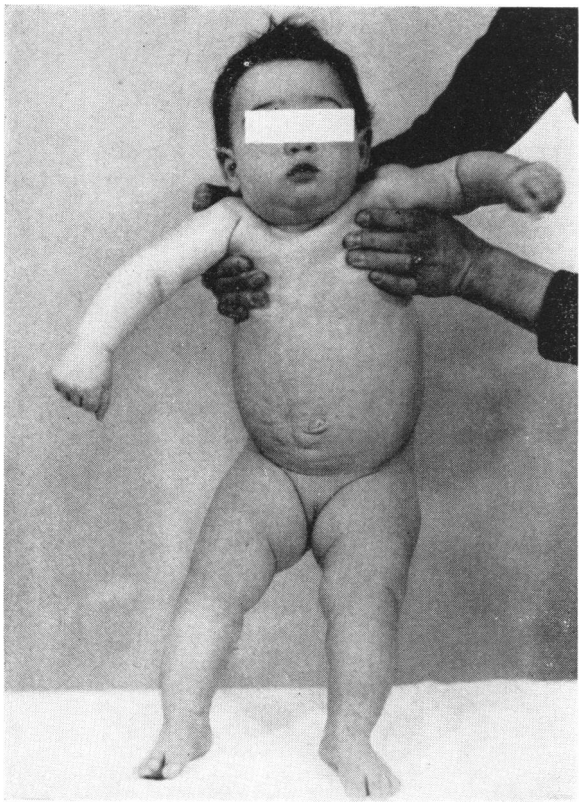

Figure 5—Photograph of the patient at 8 months of age when she weighed 15 lbs. Diarrhea persisted for 3 months after operation but at this time she was having only 2-3 formed stools daily.

primary anastomosis can be done within the next ten days. These infants tolerate double enterostomies surprisingly well provided one can provide for the delivery of the proximal bowel contents into the distal bowel (Figs. 4 and 5). This has the advantage of allowing the usually collapsed distal bowel to dilate up to a size which more nearly approaches the adequately decompressed proximal bowel at the time of anastomosis.

Summary and Conclusion

A report on 207 consecutive cases of intestinal obstruction which were admitted to the Babies Hospital during the last 17 years is presented.

The etiology, frequency of the various causes and the results are discussed. Emphasis is given to adequate follow-up study of the survivors.

The mortality was 42 per cent. It has dropped from 60 to about 30 per cent in recent years. The factors responsible for the high mortality are considered.

Although progress has been made, further improvement can be achieved by earlier recognition and treatment of these conditions through closer cooperation of the pediatrician and the surgeon.

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Discussion

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In the past few days I have had the pleasure of examining with Dr. Santulli all of the material which he has presented at this meeting. Since he has discussed the various causes of intestinal obstruction in the newborn, the operation necessary to correct each cause, the mortality, follow-up results, etc., I would like to devote the five minutes allotted to me to consideration of the subject in general terms rather than repeat many of the things he has said.

Intestinal obstruction in the newborn is always a very timely subject and one that needs presentation and discussion frequently since the mortality is still too high, the diagnosis often not made as early as it should be, the findings at operation oftentimes confusing and complex and occasionally neither thoroughly understood nor completely corrected particularly in the malrotation group. Until these things are righted we can hardly expect any marked improvement in the mortality.

Delayed diagnosis presents the most serious and most frequent problem. This does not mean that the delay necessarily occurs in the hospital for in many instances the patient is not brought in until the ideal time for operation has long since passed, thus no matter how skilfully the surgery is performed it may not be possible to correct the harm caused by delayed diagnosis. It is only fair to say that some of the conditions found at operation are so complicated and require such a long operation that it is physically impossible for a baby to stand it.

We are all well aware of the fact that a newborn baby is endowed with the power to survive an amazing amount of abdominal surgery in the neonatal period, but we must never forget for one moment that there is still a very definite limit to the amount of surgery he is able to tolerate. He will resist very vigorously up to a certain point beyond which his downfall may be precipitous and unheralded. Also a baby must never be considered as a vest-pocket edition of an adult nor treated as such.

The surgical approach to the obstruction should be as direct as possible in order to avoid rough or unnecessary handling of tissue thereby preventing many postoperative adhesions while the most careful hemostasis is also essential as these babies will not stand great loss of blood. It is now taken for granted that no baby will be subjected to an abdominal operation who has not had his lost fluids restored (a matter of an hour or two), blood ready for immediate transfusion, and in cases of obstruction, his stomach empty or a stomach tube passed and gastric suction applied to it all during operation if necessary. Aspiration of gastric contents is a very serious complication in the newborn and is easily avoidable.

Most of the abdominal surgery in the first year of life is done to correct conditions due to or the direct cause of some congenital anomaly. Infection plays a very small part in the abdominal surgery during the first twelve months, but after that time it may produce

pathological conditions similar to those occurring in adult life.

What then does a complete intestinal obstruction in a newborn baby mean from the parent's point of view? It means that their newborn baby needs to have an immediate abdominal operation which may well be more than his physical condition will allow. What are the hazards and problems we have to consider when operating upon the newborn, let us say in the first or second day after birth? They are many, but the following are a few of the most important:

1. Prematurity presents a very great hazard because the premature does not have either the stamina or vitality of a baby born at term.

2. A newborn baby may have atelectasis or his lungs may not have reached complete expansion by the time surgery becomes necessary.

3. He may have already aspirated vomitus.

4. He may have other anomalies which have not yet been discovered. He may also have more than one anomaly of his gastrointestinal tract and for this reason it is always a good plan to determine the patency of the remainder of the gastrointestinal tract after the cause of the obstruction has been corrected. This is easily done by injecting saline into the lumen of the intestine distal to the obstruction.

5. There is always the chance that the condition in the abdomen is so difficult to correct that it may require a longer and more extensive operation than the infant can tolerate.

6. The amount of general anesthesia that the operation requires may be a serious handicap to survival in predisposing him to upper respiratory infections or perhaps cardiac arrest.

The diagnosis of intestinal obstruction may always be made by taking a plain plate of the abdomen in three positions if this is possible. Barium, as a medium for the x-ray, is unnecessary and often harmful and should not be used. One only needs to know that a complete obstruction exists either high or low in the abdomen to declare an immediate laparotomy necessary.

These babies suffer from all of the ills of high or low obstruction as found in adult life. In the high obstruction there is usually continuous vomiting with subsequent loss of electrolytes and dehydration but with little or no distention except perhaps that of the stomach, while in the lower obstruction type there will be vomiting of bile-stained fluid, no passage of meconium and later abdominal distention with palpable loops of bowel or visible peristalsis. However, the diagnosis should

be made before the distention is severe or loops of bowel palpable. When a newborn baby vomits bile-stained material a potential intestinal obstruction should be considered until ruled out. Duodenal obstruction above the ampulla of Vater, where there would be no vomiting of bile, occurs much less frequently.

Newborn babies as a rule are excellent candidates for carefully planned and skilfully executed abdominal operations. They will often get well in spite of the greatest odds if given half a chance.

I would like to compliment Dr. Santulli for this excellent study of one of our greatest problems in infant surgery. He has also, by painstaking labor, acquired an excellent foundation in the follow-up which is so important in all of these cases and particularly in meconium ileus as shown tonight. This is the type of study that is bound to produce improved results in the diagnosis and surgical treatment of these seriously ill babies.

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A combined meeting of this sort is certainly most helpful in developing the necessary team work to improve the surgical care of pediatric patients. Dr. Santulli has rendered a valuable service in presenting the Babies Hospital experience with intestinal obstruction in the newborn. Both Drs. Santulli and Donovan have emphasized how important early diagnosis is for the effective treatment of the problems. Early diagnosis is dependent on an alert pediatrician keeping the likelihood of intestinal obstruction in mind and taking the necessary steps to prove or disprove it.

I would like to emphasize what Dr. Santulli touched on briefly. Diagnosis in the full term infant is relatively simple. In the premature, however, the problem is much more difficult. These very tiny infants can occasionally have actual gangrenous segments of bowel and have little outwardly to suggest it. Contrariwise, some prematures fail to

pass meconium for two to three days and yet have no mechanical obstruction to explain this behavior. Errors in diagnosis have been and, I am afraid, will continue to be made in both directions. We can only keep on trying.

Secondly, a word about preoperative preparation and postoperative care of the newborn with intestinal obstruction. Time does not allow any detailed discussion of these important aspects of management which often fall under the supervision of the pediatrician. Let me just say in passing that we feel it important initially to evaluate the infant's state of fluid and electrolyte balance, and to get replacement fluids started before taking the baby to the operating room. We think that much valuable time may be lost if anything like complete correction of deficits is attempted before surgery is started.

With regard to postoperative care, experience at Babies Hospital has suggested that errors on the side of dehydration seem to be better tolerated than errors on the side of overhydration. In general we tend to keep the babies on a relatively small fluid intake with restricted electrolytes.

Lastly I was interested in Dr. Santulli's figures of the finding of meconium ileus as a cause of intestinal obstruction as compared with atresia and stenosis of the bowel. He showed that there were considerably more than half as many due to meconium ileus as due to atresia and stenosis. This is a higher proportion than I had expected. To a degree, I am sure, this is influenced by the considerable interest at Babies Hospital in cystic fibrosis of the pancreas. Thus newborn siblings of known cases of cystic fibrosis who get into trouble may be brought to the hospital because of the family's previous connection here. But even allowing for the slight overweighting of our figures because of this factor, the incidence of meconium ileus as a cause of neonatal obstruction is very high and the surgeon should be prepared to find such a condition frequently.

In closing I would like to emphasize again what Dr. Santulli and Dr. Donovan have already stressed: that early diagnosis is one of the most important factors in saving such babies' lives. This part of the life-saving procedure rests squarely on the shoulders of the pediatrician.