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A Review of acute abdominal surgery in infancy and childhood

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A REVIEW OF ACUTE ABDOMINAL SURGERY
IN INFANCY AND CHILDHOOD

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Submitted in Partial Fulfillment for the Degree of
Doctor of Medicine

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INTRODUCTION

Since I am interested in both the field of surgery and that of pediatrics, I have decided to combine a portion of each of these specialties in writing the following thesis.

An endeavor is made to cover each subject on a statistical basis from the standpoint of incidence, history, signs, symptoms, diagnostic laboratory procedures, differential diagnosis, diagnosis, preoperative care, surgical treatment, postoperative care, complications and mortality. I have reviewed the literature in order to compare my findings with those of other investigations.

Where debate arises concerning the diagnosis or care of certain aspects of a disease, I have tried objectively to review the literature in an effort to decide which side of the debate seems more logical, practical and successful.

The statistics I shall present have been taken from the hospital charts of those individuals, twelve years and under, who entered Childrens Memorial Hospital, Omaha, Nebraska between April, 1948 and December, 1953. The relative number and mortality of each is listed on Table I.

TABLE I. ACUTE ABDOMINAL SURGERY IN INFANCY AND CHILDHOOD

<u>Type of Disease</u>	<u>Number of Cases</u>	<u>Mortality</u>
Appendicitis	284	0
Hypertrophic Pyloric Stenosis	131	0
Intussusception	42	4
Intestinal Obstruction	47	16
Meckel's Diverticulum	12	0
Biliary Obstruction	8	1
Trauma	9	0
Foreign Body	3	0
Omphalocele	2	2
Primary Peritonitis	4	0
	442	23

GENERAL CONSIDERATIONS

Before considering any specific disease entity it seems logical that a few statements should first be made to bring out certain idiosyncrasies in infants and children which lead to problems in the diagnosis and treatment of acute abdominal disease in general.

In reading the literature, I find that the most constant point presented as a contributing factor to the decrease in mortality in these individuals, has been earlier diagnosis and treatment. This is attributed to a more general awareness by the public of the signs of abdominal disease. The members of the medical profession have also developed a keener insight into the peculiarities of the psychic and physical make-up of infants and children.

For the most part, the history of the disease comes not from the patient, but from one who has observed him. In the infant it is not the pain which first points out to the observer that something is wrong; it is, instead, a matter of fussiness, irritability, crying, flexing of the thighs, refusal to eat, or constipation. In older children knowledge of the type of pain can be of great assistance in differentiating between that due to peritoneal and that due to visceral irritation. Edwards' (1) classification of these two types of pain is as follows:

<u>Peritoneal</u>	<u>Visceral</u>
Localized	Diffuse
Constant	Intermittent
Reflex rigidity of abdominal wall	No rigidity
Elevated temperature	Normal or subnormal temperature

Since the child usually cannot relate well, the duration of symptoms is often obscure. In addition there is often a tendency on the part of the observer to err on the side of longer duration than actually exists. A nervous, gravely concerned mother may easily obscure the history by being over anxious. As Hoerner (2) pointed out, there is usually no effort made by older children to obscure the history. Their minds are not confused by the fear of possible surgery or the fear of gaining sympathy, but the nervous system of a child is much more labile; this leads to a more marked reaction to psychic stimuli. For this reason positive statements are essentially truthful, but negative statements cannot be relied upon. Apfel (3) stated that the average child is much less disturbed by the pain of acute abdominal disease than the adult. This is due to the underdevelopment of his nervous system.

From these points it is seen that more emphasis must be placed on doing an accurate, discerning physical examination on these patients. The main complaints are usually brought out by the parent, but the definite sequence of complaints and symptoms which make up an accurate history are often lacking.

Physical examination in this age group is also altered from that of the adult. Gentleness is the watchword. The abdomen and the least tender quadrant of the abdomen is best examined first. As directed by Hoerner (2), the relatively different anatomical position of abdominal organs and the thinness of the musculature .

and fat pads must be remembered. With this in mind palpation of a loop of bowel or cecum may lead one to believe that a pathological mass is present. Norris and Brayton (4) recommend inspection of the respiratory wave to discern whether it passes down over the abdomen with the idea in mind that if it does, one can be fairly sure that no involuntary muscle spasm exists. If this be equivocal, only patience will form the distinction between voluntary and involuntary spasm. Concerning palpation, they suggest two to three applications of the hand with each positioning, each application being firmer than the preceding. It is to be remembered that rigidity is rare in infants even when severe disease exists. On the other hand, distention and tenderness are easily elicited. Localization of the latter is more difficult. Mild sedation may be helpful in this respect. Strang (5) offered a method of examination. He suggested placing infants and small children to their mother's breast with arms and legs embracing her. The examining hands are then placed on the right and left iliac crests. The fingers are extended across the abdomen pointing in the direction of the umbilicus. Upper quadrants are palpated first. Rectal examination can be of considerable help in localizing pain.

Concerning routine laboratory data, Norris and Brayton (4) reminded their readers that the newborn has a normally high hemoglobin and erythrocyte count; infants from two to twenty months have a normally low hemoglobin. They stated that the white blood

count is more labile to dehydration and brought out the recognized fact that the granulocyte response to infection may be late or non-existent in very young individuals.

When one must resort to laboratory aids, an antero-postero and lateral flat plate of the abdomen are often of great help. Norris and Brayton (4) stated that a barium swallow is rarely necessary and may be quite detrimental. The dangers are: 1) aspiration and 2) barium sulfate tends to delay normal gastro-intestinal activity postoperatively. It may even cause obstruction especially in infants.

Food, fluid, and electrolyte balance are of tremendous importance in infants and children. The ease with which acidosis may overtake a child is well recognized. As a result of their labile metabolism, constant tissue demand due to growth, and relatively large fluid requirements in relation to their size; inadequate intake or excessive output of body fluids and electrolytes can swiftly upset their delicate acid-base balance. Proper attention to these factors both before and after surgery has been of great importance in decreasing mortality rates in the last two decades.

PART I

APPENDICITIS

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APPENDICITIS

Two hundred eighty-four acute surgical conditions in this series were due to appendicitis, thus this disease entity remains and probably always will remain most common. Of these cases 40 or 14.1% were ruptured. There were 20 cases or 7.5% of abscess formation and an equal number of localized or diffuse peritonitis. No deaths were recorded. Table II contains reported series and types of pathology in relation to mortality. This relationship will be discussed below.

INCIDENCE

Only children 12 years and under were included. The average age was 7.7 years with a peak incidence at 10 years. (Graph A) The youngest child was 9 months. Younger children have been reported, but the incidence is rare. That appendicitis is a grave disease in the very young was well displayed by the work of Snyder and Chaffin (6) in 1952. They collected and reported 447 cases from the literature. All individuals were 2 years and under; perforation had developed by the time of operation in 71%; overall mortality was 29%. The same year Benson, Coury and Hagge (7) reported 39 cases in this age group. Only 3 were under 12 months, the youngest being 7 weeks old. Their 15-year mortality was 15%. Six or 2.1% of the patients in this paper were under the age of 2 years; 19 or 3.4% were 3 years and under; 41 or 14.4% were 4 and under; 98 or 34% 6 and under.

Graph A
 APPENDICITIS
Seasonal Incidence



According to Gross (8), the sex incidence is approximately 55% male and 45% female. Table II shows the variation in reported series. This ratio is slightly higher than the sex ratio of the general populace; however, little weight can be placed upon it, except in the younger age group. Benson, Coury and Hagge (7) found 69% males in their 39 cases two years and under; Dennison and MacPherson (9) 70% males in 82 cases three years and younger; eleven or 58% of the patients of that age group in this series were males. The significance of this finding is questionable but interesting. If it be truly significant, the explanation may possibly be based upon the fact that appendiceal lymphoid tissue is more abundant in the male as described by Hwang and Krumbhaar (10).

The infrequency of the disease in negroes is referred to in the literature. In this report 6 or 2.1% were negroes; Taylor and Hodges (11) 8.6% of 326 cases; Litchfield (12) 10% of 124 cases; Benson, et al (7) 5 of 39 cases at a time when the two races were equally represented on the surgical wards; Abel and Allen (13) 3% of 1165 cases.

I found a definite seasonal incidence as shown in Graph A. There was a definite increase in cases from March through May, a peak in August, another rise from November through January. It is well known that these are the months when upper respiratory infections are most common. This was a finding in 174 or 61.3% of the cases presented here. Such a finding may seem unusually high, but

in each instance the chart revealed recorded evidence ranging from mild tonsillar or pharyngeal injection with or without palpable cervical nodes through follicular tonsillitis and otitis media. Hoerner (2) and Abel and Allen (13) found autumn and winter peaks in association with upper respiratory infection; Benson, et al (7) had 71.7% and Packard and McLanlthlin (14) 60% occurring in winter and spring; in Stuckey's series (15) autumn showed highest incidence; Evans' (16) 236 cases were charted 86% as having associated upper respiratory; Hamilton (17) found 52%. Schroeder (18), Sauer and Bailey (19), Behrend (20), Brenneman (21) and McLaughlin and Davis (22) have articles condemning upper respiratory infections as either contributing factors in the etiology of many cases of appendicitis or as a frequently co-existing finding.

To the contrary Scott and Ware (23) found no seasonal relationship in 506 cases covering a span of five and one-half years. Hudson and Chamberlain (24) reported that most of their cases occurred during spring, early fall and winter and noted that this was apparently the same curve as that of respiratory infections. They found by means of standard deviations that the incidence variations could be chance, but that there was no proof that they were by chance alone. They therefore concluded that the finding was statistically not significant. They also noted an upper respiratory infection incidence of 14.9% and stated that this was approximately the expected incidence of such a finding in the general

population (16%). Gross (8) also believes that there is little statistical proof. However, he found that about 20% had such an associated infection, and that there was a greater frequency of appendicitis during March through April. He concluded that there might possibly be a relationship. The above five men are all members of the same surgical service; their findings do not explain the 61.3% incidence in this series.

DIAGNOSIS

Most writers feel that the disease progresses through the same chronological sequence of symptoms and signs as in the adult: onset with abdominal pain (epigastric, paraumbilical, or localized over the appendix); followed by nausea and vomiting or nausea alone; tenderness over the appendix; leukocytosis; and fever. As stated previously, diagnosis is difficult in children under five years of age. In this age group as well as in older children further difficulty is encountered, due to the frequency of atypical cases. Nelson (25) states that one of the most reliable diagnostic features is persistent abdominal pain of more than twelve hours duration associated with vomiting. Evaluation of the presence or absence of tenderness requires keen judgment. Gross (8) states that it is the most important single finding. Rectal examination may be of great assistance here. Hudson and Chamberlain (24) found 74%, and Scott and Ware (23) 87% of rectal exams were positive for tenderness

or mass. McLaughlin and Davis (22) stated that: "In the absence of pathology in the throat, chest, and kidney; abdominal tenderness associated with nausea and vomiting indicates peritoneal inflammation". Many writers feel that findings of abdominal pain, vomiting, and slight temperature should be considered those of appendicitis until proved otherwise, and that close observation or even hospitalization is indicated. (References 24, 23, 8, 26) Stuckey (15) concluded after reviewing over 2,000 case records that: "For all practical purposes one must assume that in childhood pain plus abdominal or rectal tenderness equals appendicitis unless there are very good grounds for deciding otherwise. These are the only constant symptoms." It is well to remember that muscle guard and rigidity appear quite late in children, and the white blood count can be entirely misleading.

The initial complaint is that of pain in 75%--95% of cases (Table II). Most series report 90% or over. The most frequent location is para-umbilical or epigastric, but occasionally the onset is localized over the appendix. Vomiting was the initial symptom in 6% of the 284 cases here presented. The symptom of nausea and vomiting ranges in occurrence from 80% to 95%. In this report 9.2% experienced nausea alone and only 44.7% suffered vomiting as well. The incidence of tenderness is from 75% to 99%. Rigidity or muscle guard was recorded in only 47.5% of the cases here recorded. Occurrence in the literature is approximately 75%. McLaughlin and

TABLE II. ACUTE APPENDICITIS: COMPARISON OF CLINICAL FINDINGS

Author	% Male	% Fem.	% Prev. Attacks	Assoc. URI % no yes	% Init. Pain	% Pain	% Nausea Vom.	% Tender	Guard or Re- bound	% Chills	% Disten- tion	Temperature Not Perf.	Aver. Perf.	White Blood Count Not Perf.	Average Perf.	Perf.			
Litchfield & Denbo(27)1921																			
Cases:116	62	38			90		95	83	76		6.8	19	101		16,000				
Cohen(28)1927																			
Cases:312	62	38	21	8.6	75		85	75	75						17,000				
Hudson(29)1934																			
Cases:200					99		92.8	94.4	83.4										
Hamilton (17) 1938																			
Cases:76			36	52	75		75	90	75				100.2		16,000				
Hudson & 1938 Chamberlin(24)																			
Cases:848	54.2	45.8	30.5	no	14.9		99	82.8	99	88.2	10.7								
Litchfield(12) 1943																			
Cases:124	62	38			100		95	77.4	70.9		6.4		100.5		16,000				
Norris (30)1944																			
Cases:1000	51.2	48.8					94.9	85.7	98.9	68.1	22.1	1.8	6.2	100.7		16,700			
Scott & Ware (23) 1944																			
Cases:506	59	41	16	no	16		99	83	98	77.7			100.2	102					
Morton, Jr. & Kelby(31)1948																			
Cases:100	51	49						39	32	37					11,351				
McLanahan(26) 1949																			
Cases:823	60	40											100	101.6	14,200	17,926			
This Series Cases:284	50.4	49.6	35.2		61.3	88.0	99.3	44.7	79.6	47.5	25	1.1	2.5	100.1	100.3	101.3	13,905	14,867	20,864

the literature that the temperature and white blood count are unreliable. The lowest temperature in a perforated case was 99.2^R; the child was 10 years old and had a count of 10,300. Pathology noted was acute diffuse suppurative appendicitis with abscess. The lowest count was 5,700 in a 9 year old child with spreading peritonitis! As a rule however, a temperature above 101° with no other evidence of disease is suggestive of perforation. Gross (8) quotes 102°F. as rare unless peritonitis exists.

The average white blood count was 14,867; non-perforated 13,905; perforated 20,864. Again quoting Gross: "Counts above 18,000 to 20,000 are apt to imply that local or general peritonitis exists".

DIFFERENTIAL DIAGNOSIS

McLaughlin and Davis (22) quoted Smith's (32) analysis of 146 children admitted to the hospital with a major complaint of abdominal pain. He found that 68% had acute surgical abdominal disease. McLaughlin and Davis (22) further stated that since appendicitis is the most common acute surgical lesion, the differential diagnosis resolves itself into the differentiation between appendicitis and the more common medical conditions. Most authors feel that whenever there is reasonable doubt concerning the diagnosis, it is safer to err on the side of laparotomy than it is to defer operation. Nelson (25) excludes cases of pneumonia from this group. He cites the following as medical diseases to be ruled out in early infancy: colic, gastro-enteritis and pyelitis.

Davis (22) stated that this finding should never be considered essential in making a diagnosis and reiterate that it is a late sign, indicating progression of the inflammatory process from the visceral to the parietal peritoneum.

Various other findings in the history and physical are infrequent but of varying importance. The occurrence of previous attacks is listed in Table II. Chills are a sign of sepsis, and early active treatment is mandatory. In five articles constipation was noted as follows: Norris (30) 13.1%, Hudson and Chamberlain (24) 15.8%, Dennison and McPherson (9) 17%, Scott and Ware (23) 26%, Litchfield (12) 94%. Diarrhea was recorded from the following references: Litchfield (12) 3.2%, Hudson and Chamberlain (24) 8.7%, Norris (30) 9%, Scott and Ware (23) 16%, Dennison and McPherson (9) 29.3%. The charts covered in this paper indicated a 2.1% occurrence. This finding is usually indicative of appendix lying on sigmoid, spreading peritonitis, or pelvic appendix most often with abscess. Gross (8) warns that appendicitis occasionally occurs during the course of gastro-enteritis and that any change for the worse in such a patient demands thorough investigation. Distention is infrequent, but when present, indicates paralytic or adynamic ileus. Hudson, Chamberlain (24), Scott and Ware (23) obtained a history of dysuria in approximately 7% of their combined 1,354 cases.

The average temperature was 100.3^R; 100.1^R with simple appendicitis; 101.3^R in perforated cases. There is general agreement in

1. Colic. In infancy "colic" designates episodes of abdominal discomfort instigated by one or more of the following: hunger, the swallowing of air, overeating, nervous environment and occasionally allergy. McLaughlin and Davis (22) noted that it tends to recur at the same time each day and is best treated by proper feeding and atropine. Heiman and Cohen (33) proposed the assertion that it is the most frequent cause of abdominal pain between the ages of four and twelve years. The symptoms in older children are usually those of para-umbilical pain, vomiting and constipation. McLaughlin and Davis (22) stated: "Attacks tend to occur at intervals of several weeks; there is no local tenderness, increased temperature or white count, muscle guard or rigidity. Frequently a spastic cord-like bowel can be palpated." Lead poisoning, though infrequent, is to be remembered.

2. Gastro-enteritis. Diarrhea is not infrequently present with appendicitis; however, history of its presence in the family and absence of significant localized tenderness help to distinguish it. Nelson (25) suggests withholding food for a period and administering a saline enema. The latter is a debatable procedure. He also suggests 10 to 15 cc. of mineral oil every 4 hours and close observation.

3. Pyelitis. Pain in this disease may be unilateral or bilateral and is more likely in the flank with tenderness in the costo-vertebral-angle. Higher fever and white count, chills and pyuria

help to distinguish it. McLaughlin and Davis (22) pointed out that an extracecal or a high retrocecal appendix may simulate this even to the point of pyuria.

The more common diseases in older children are the following: (Nelson (25)) acute digestive upsets, food poisoning, gastroenteritis, pyelitis, acute mesenteric adenitis, pneumonia, rheumatic fever, and occasionally acute contagious processes. Constipation should be added to this list.

1. Acute mesenteric adenitis. This is almost invariably accompanied by an upper respiratory infection. Pain may be general or localized. Since the lymph nodes are larger and more numerous in the region of the ileo-cecal junction, localization is frequently in the right lower quadrant. Gross (8) states that nausea and vomiting seldom occur and that the white count rarely exceeds 10,000. The following men agree that if there is reasonable doubt, laparotomy should be undertaken. Nelson (25) believes this procedure to be conservative. Norris and Brayton (4), Gross (8), Brenneman (21), McLaughlin and Davis (22), Weeder (34), Southam (35), Malloy, Jason and Drew (36), and Stuckey (37) believe that appendectomy is the treatment of choice in order to relieve the patient of further attacks of pain as well as to rule out an inflammatory process.

2. Pneumonia. Adams and Bergen (38) found that 17.6% of 145 cases with an initial diagnosis of appendicitis had pneumonia. The temperature, pulse, respirations, and white count are usually higher;

breathing may be shallow with grunting expiration, movement of the alae nasi and cyanosis. As explained by Nelson (25), the right lung may irritate the adjacent intercostal nerves causing referred pain, tenderness and even muscle spasm.

3. Constipation. According to Gross (8), constipation may cause pain, nausea and even vomiting. Temperature and white count are usually normal; there may be tenderness due to distention of the cecum. He suggests a warm soap suds enema and re-evaluation after a short period. It is his feeling that little harm can be done by evacuating the bowel.

The following are less frequent differential diagnostic entities: Henoch's purpura, tuberculous mesenteric adenitis, primary peritonitis, abdominal pain associated with measles, varicella, scarlet fever, rheumatic fever, anomalies of right ureter, onset of menses and regional ileitis. Differentiation from other surgical disease entities will be discussed in their respective sections of this paper.

TREATMENT, MORBIDITY, MORTALITY

There seem to be three debatable points in the management of acute appendicitis. They are the following: when to operate, which type of incision is preferable, and whether or not drainage is the procedure of choice when the appendix has perforated. Since these points are intimately related to morbidity and mortality, the opinions of the major contributing surgeons and their relative morbidity and mortality are listed in Table III. From this comparison

TABLE III. ACUTE APPENDICITIS: COMPARATIVE METHODS OF TREATMENT

FOR IMMEDIATE SURGERY	AGAINST IMMEDIATE SURGERY
Hudson and Chamberlain (24) 1929-1938, 848 cases, mortality 3.06%. Stat. surgery following build up. Right rectus incision. Incision over mass if abscess. Drainage: non-perforated 21.7%; perforated with appendectomy 89%-drainage only 11%, 21 cases postoperative intestinal obstruction.	Miller, Fell, Brock and Todd (43) 1940. If left alone, a mass represents slow leak against which an adequate defense has been built. <u>Vast majority resolve.</u> Oberhelman (44) 1943. With conservative measures in adults and children when mass or spreading peritonitis mortality reduced to 2.2%.
Hipsley (39) 1930-1940. 3,252 cases. Mortality 1.8%. Stat. surgery with decision then to remove or wait until later. Drain on slightest leakage.	Oberhelman and Austin (45) 74 cases non-operated localized peritonitis or abscess. Mort. 2.8%. 64 cases general peritonitis with early surgery. Mort. 7.3%. Drainage, 90. 5.8% Mort. No drainage: 51. 5.5% mortality.
Taylor and Hodges (11) 1935-1940. 326 cases. Mort. .61%. Stat. surgery. 95% McBurney incision. 3 cases postoperative intestinal obstruct.	Meyer, Requarth and Kayall (46) 1946. 5,443 cases all ages. Lower mortality in abscess cases due non-intervention. McBurney incision. Lower mortality when <u>drains not used.</u>
Allen (40) 1936-1940. 293 cases. Mortality 1.7%. Stat. surgery. No first surgery appendectomy in 8. 1 died.	Schultz (47) 1948. 3.4% mortality in non-operated group. 4.7% in <u>operated group with perforation.</u>
Deaver (41) 1930-1941. 417 cases. Mortality 3.6%. Stat. surgery. Progressive increase in McBurney incision with progressive decrease in mortality. No appendectomy in 1 of 85 cases peritonitis--patient died. No appendectomy in 4 of 35 cases abscess--1 died. 6 cases postoperative obstruction.	Riker (48) 1946-1949. No hard fast rules if abscess well walled off and patient non-toxic observe. 56 perforated cases. Mortality 5.5%. <u>Appendectomy if accessible.</u>
Penberthy, Benson, Weller (42) 1,653 cases. Mortality 4.2%. Early surgery. Para rectus not much difference from McBurney due to relatively small distance between the two in infants and children.	Stuckey (15) 1946-1950. 2,206 cases. Mortality .3%. Abscess mortality 1.9%. Peritonitis mort. 8.2%. With abscess incise over it and drain. Appendectomy 3-6 months later unless easily accessible.
Norris(30) 1924-1944. 1,000 cases. Mortality 3.2%. Stat. surgery with deferred surgery only in exceptional cases. Abscesses frequently cause obstruction. Mortality inversely proportional to McBurney incision. 12 cases intestinal obstruction.	If pelvic abscess treat conservatively. <u>Peritonitis-Stat. surgery.</u>

Table III continued.
See next page.

TABLE III. ACUTE APPENDICITIS: COMPARATIVE METHODS OF TREATMENT

FOR IMMEDIATE SURGERY (Continued)

Scott and Ware (23) 1939-1944. 506 cases. Mortality 1.58%. Early operation. Right rectus lateral retracting 41%. Incision and drainage only in 7%. 34 post-operative pelvic abscesses. 2 drained spontaneously rectum. Rest resorbed or evacuated by drain sinus. Intestinal obstruction in 7.3% of 234 perforated cases.

McLanahan(26) 1933-1949. 823 cases. Mortality .24%. Prompt surgery.

McBurney. 7 cases drainage first. 8 postoperative abscesses. 19 wound infections. Antibiotics have lowered morbidity but surgical judgement and technique responsible for decrease mortality.

Packard and McLanlthlin (14) 1945-1950. 329 cases. Mortality .3%. Right rectus 60%. Drainage 83% of localized and 88% diffuse peritonitis. 3 cases postoperative obstruction.

Gross (8) 1944-1951. 729 cases. Mortality .14%. Immediate surgery with appendectomy 98%. McBurney incision with right rectus reserved for doubtful cases. Drainage in generalized peritonitis in recent years. Find less morbidity with drainage. 30 cases early postoperative obstruction.

it appears that there is lower morbidity and mortality when surgery with appendectomy is performed immediately after adequate preoperative build-up. In 273 or 96.1% of the cases recorded here immediate surgery with appendectomy was performed.

Gross's (8) preoperative care in perforated cases, especially for peritonitis cases, seems all encompassing. It is as follows: adequate sedation, constant gastric suction, intravenous fluids, electrolytes and blood if necessary, adequate antibiotic therapy, 95% oxygen if distention occurs, and Fowler's position. The length of this therapy depends upon the individual patient. As an arbitrary rule, Gross recommends the combination of adequate hydration, appearance of the child, pulse below 130, and temperature below 103°F. as helpful in deciding on the time of surgery. He further states: "There is seldom justification for putting off operation beyond twelve hours." The anatomic and physiologic reasons for rapid perforation and progression of peritonitis in children under the age of six years have been adequately recorded by McLaughlin and Davis (22). These reasons, listed below, seem to be irrefutable proof that early surgery is the wisest choice:

(a) The cecum lies higher and the appendix is less often retrocecal than in older children, making the chances for general peritonitis greater when perforation occurs. (Carson, H. W.) (49)

(b) The lumen of the appendix is proportionately large, offering material free entrance into the appendix, with the possibility of obstruction.

(c) Lymphoid tissue gradually increases in the appendix of the child as the latter grows older, with its susceptibility to infection. (Fraser, J.) (50). Fox (51) noted that children have a large amount of lymphoid tissue which may allow easier and earlier perforation. Average age of perforation in his 178 cases was 5.9 years. In my series the average age was 6.5 years.

(d) The virulence of *Bacillus coli communis* in the infant increases with age. (Fraser)

(e) The appendiceal wall in young children is thin, offering little defense to virulent infection. (Fraser)

(f) The omentum is underdeveloped at this age, giving little protection. (Poynter, G. W. M.) (52)

(g) The long mesocecum usually present at this age increases the mobility of the cecum. (Stone, J. S.) (53)

Moot evidence that these factors are of especial importance in younger children is the work recorded by Dennison and MacPherson (9) covering the period from 1946 through 1950. They presented 82 cases under the age of 3 years; 57 were males; 6 simple appendicitis; 15 local peritonitis; 25 diffuse peritonitis; 36 had abscess. Mortality was 6%. Benson, Coury and Hagge (7) presented 39 cases under the age of 2 years; 69% were male and 6 deaths were recorded, all of which occurred prior to 1941. Before that time conservative therapy had been used in patients with diffuse peritonitis. From 1947-1952 fewer drains were used in their practice; they found a decreased

incidence of postoperative intestinal obstruction but more residual pelvic infection. However, they stated that chemotherapy and antibiotics had considerably lowered the morbidity from this.

The procedure of choice when an abscess is present seems to be the same as for peritonitis with the exception that the incision is made over the mass in order to prevent soiling of the peritoneal cavity. If the patient's condition is satisfactory, appendectomy is performed unless dense adhesions or marked vascular granulation tissue surrounds the organ.

The incision of choice is the McBurney unless the diagnosis is doubtful. In the opinion of Abel and Allen (13), this incision is preferred for the following reasons: 1) minimal peritoneal irritation, 2) less damage to the nerves and blood vessels, 3) best exposure for the expected abnormal findings, 4) if retrocecal, lateral extension easy, 5) if medial, Wier's extension, 6) lower incidence postoperative hernia, 7) the incidence of its use is inversely proportional to postoperative morbidity and mortality. Meyer, Requarth and Kayall (46) concluded from 5,443 cases covering all age groups that, "The closer to midline the incision is made, the higher will be the mortality."

As stated by Slattery, Yannitelli and Hinton (54), decrease in the use of drains is not a clear cut factor in lowering the mortality. I conclude from reading the literature, that when properly placed well against the lateral abdominal wall, the use of soft drains,

removed prudently, does decrease the morbidity.

The majority of surgeons agree that the greatest single factor contributing towards lower mortality has been earlier hospitalization and treatment. That period between 24 and 36 hours after the onset of symptoms seems most dangerous. Associated with decreased mortality through the years, have been advances and refinements in the following therapeutic aids: 1928-1932, intravenous fluids and intragastric suction; 1937-1938, blood; 1944-1945, chemotherapy and antibiotics. Progressive improvement in surgical care has been presented above.

PATHOLOGICAL TYPES

In classifying appendicitis I chose the following: acute--catarrhal, suppurative, gangrene; ruptured with abscess; ruptured with local or diffuse peritonitis. A record of the larger series in the literature is to be found in Table IV. It is obvious that there is an inverse relation between the percentage of unruptured cases and the percentage of mortality. In this series of 284 cases 85.9% were unruptured. This is very commendable, as is the lack of any deaths. The pathological reports on this series are shown in Table V.

TABLE IV. ACUTE APPENDICITIS: COMPARISON OF MORTALITY WITH PATHOLOGICAL TYPE AND TREATMENT

Author	Year	Cases	% of Admissions Abdominal Disease	Acute Catarrhal Suppurative Gangrene	% of Cases	Mortality	Rupture: abscess	% of Cases	Mortality	Rupture: Peritonitis	% of Cases	Mortality	% Treated by Drainage	Deaths	
														No.	%
Litchfield & Denbo (27)	1921	116	60	42	34		15	12		59	47		59	29	25
Lanman (55)	1921	223	32.3	122	55	9	65	29.5	9	36	16.1	33	45-	29	13
Beekman (56)	1925	316	Infections											22	7
Cohen (28)	1927	312	Infections										57	13	4
Horgan & Horgan (57)	1929	236	74	133	55.6	.01	28	11.6	17.8	75	31.7	18.6	43	20	8.4
Keyes (58)	1934	380		Inc. chronic & recurrent 216	56.8	3.58	Abs. & Loc. 122	32.2	9.02	42	11.5	38.1		30	7.89
Hudson (29)	1934	200	65		53			31			16		60		
Deaver (59)	1930-1938	235		146	62.1	0	14	5.9	7.1	75	31.9	12		10	4.1
Hudson and Chamberlain (24)	1929-1938	848		475	56	.42	156	8.5	1.9	149 loc. 217	35.5	24.8	56	26	3.06
Hipsley (39)	1930-1940	8252													1.8
Jacobson (60)	1934-1940	918		39 chronic 708	77.1		18	2		192	20	5.2	40.9	12	1.3
Taylor (11)	1935-1940	326		210	64.6	0	33	10.1	0	83	25.3	2.4		2	.61
Allen (40)	1936-1940	293		195	66.5	.51	26		(1) 3.8	71	24.5	(3) 4.2		5	1.7
Deaver (41) under 14	1930-1941	417		298	71.4		34	8.1		85	19.9			11	2.6
Penberthy, Benson & Weller (42)	1927-1942	1653		742	45.4	.44	292	17.6	3.6	277 94 diffuse 35 non-op	37	22.4 (64.9)		64	4.2
Norris (30) to 16½ yr.	1924-1944	1000			74.9			9.5			15.6			32	3.2
Scott and Ware (23)	1939-1944	506		272	53.7	.36	48	10.6		186	36.7	3.7		8	1.6
Abel & Allen (13)	1926-1947	1165		708	60.7		200	16.4		267	22.9			44	3.8
McLanahan (26)	1933-1949	823		712	86.5	.14								2	.24
Stuckey (15)	1946-1950	2206							1.9			8.2		66	.3
Fox (51)	1946-1950	178		110	61.7	0	15	8.6		53	29.7			3	1.6
Packard & McLanlthlin (14)	1945-1950	329			59.2									10	.3
This Paper	1948-1953	284		244	85.9	0	20	7.04	0	20	7.04	0	5.6	0	0

TABLE V. ACUTE APPENDICITIS: PATHOLOGICAL REPORTS ON THE 284 CASES.

<u>Cases</u>	<u>Pathological Type</u>
28	Suppurative
14	Acute diffuse suppurative
36	Acute focal
64	Lymphoid hyperplasia
43	Lymphoid hyperplasia with acute focal
2	Lymphoid hyperplasia with chronic
2	Suppurative with chronic obliterative
2	Lymphoid hyperplasia with chronic obliterative
1	Acute focal with Chronic obliterative
1	Chronic obliterative
2	Chronic
6	Gangrene
6	Abscess
1	Peritonitis
1	Abscess resorbed
<u>14</u>	Vermiform appendix
284	5 with pinworms
	1 with a kink
	1 with foreign body (buck shot)
	3 with fecalith

Pinworms were noted in a total of 19 cases or 6.7%. In 5 cases no inflammation was noted. Their occurrence in the literature varies from Packard's .9% of 329 cases (14) through Scott and Ware's 11.8% of 506 cases (23). The latter men noted that of 60 cases 25 were inflamed and 35 showed no microscopic sign of inflammation. They concluded that pinworms may possibly form a bolus and cause obstruction in the same manner as a fecalith. I believe this to be true. That gross inspection and microscopic tissue inspection for pinworms is misleading was discovered by Schenken and Moss (61). By repeated centrifuge of appendiceal contents until the supernatant fluid was clear they found that 31.2% of 400 appendices taken from all age groups revealed enterobius vermicularis. The incidence in negroes was one-third of that found in white patients.

In 21 or 7.4% of cases a fecalith was noted. Hudson and Chamberlain (24) found an incidence of 43.5%; 58% were noted in perforated cases. Scott and Ware (23) noted a 40% incidence with 66% in the perforated group.

Before discussing lymphoid hyperplasia as a pathological type, comment should be made concerning normal appendices found. In 284 cases there were 14 or 4.9%. Associated findings are noted above. Paulson (62) reviewed 10,000 cases with no age limitation and found 44.8% to be normal. He stated that a sign of good diagnosis is 20% vermiform appendix and quotes others: Sappington and Horneff, 60.3% of 937 cases; Aschoff, 35% of 847 cases; Jaffe and Wells, 27.4% of 1,000; Mason, Allen, et al., 18.6% of 1,000.

The reader is immediately struck with the thought that figures ranging from 35% to 60% are indeed a sign of alarmingly poor judgment. If these figures be true, then the number of normal appendices removed from children should be a great deal more, for diagnosis in children is much more difficult. I am convinced that at least partial explanation lies in the fact that there are too few pathologists who recognize lymphoid hyperplasia of the appendix as a pathologic entity.

LYMPHOID HYPERPLASIA

Of the 284 cases, 123 or 44.3% were reported as showing lymphoid hyperplasia alone in 22.5%, or its association with acute focal 15%, suppurative 4.9%, or chronic appendicitis .7%. As stated above 174 or 61.3% of the entire series had evidence of upper respiratory infection and 35.2% had had previous attacks. The cases displaying lymphoid hyperplasia had a 60.1% incidence of respiratory infection and 44.6% of previous attacks.

The paper of Malloy, Jason and Drew (36) concerning the role of lymphoid hyperplasia in acute appendicitis refers to the following men as investigators into the question of why abdominal pain is frequently noted in the course of upper respiratory infection: Brenneman (63), 1922; McLanahan (64), 1934; Wilensky (65), 1941; Dreamer and Capp (66), 1952. Earlier studies concluded that many of these cases were associated with mesenteric lymphadenitis: Goldberg and Nathan (67), 1934; LaMarnierre (68), 1937; Adams and

Olney (69), 1938. Malloy et al. also stated that it is well known that lymphoid hyperplasia and mesenteric adenitis occur as well in the course of acute gastroenteritis, typhoid fever and tuberculous enteritis. They further state that the hyperplasia takes place in many subjects as part of a generalized response of the tissue to infection. The work of Bowers (70), Gray and Heifetz (71), and Held and Goldbloom (72) supported the observation that the lymphoid tissue in the appendix may share in this response. Rafferty (73) recorded extremely interesting data concerning *Histoplasma capsulatum* and the appendix. In 436 cases classified as chronic, lymphoid hyperplasia and normal 54 or 10% contained this organism. All were the site of marked follicular hyperplasia.

Gray and Heifetz (71) quote the following men as earlier writers recognizing the abundance of this tissue in the appendix: Watzgold 1907, Klemm 1906, Miloslavich 1912, Moschiowitz 1916, Barss 1918, Synners and Greenberg 1919, Stout 1927. These men considered the finding a phase of so called "status lymphaticus".

Wangensteen, Buirge, Dennis and Ritchie (74) have produced the pathologic and clinical features of acute appendicitis in experimental animals and surgical patients by occluding the lumen of the organ and thereby causing a closed loop obstruction. They concluded that this was the prime factor in the pathogenesis of inflammation of the organ. Malloy et al. (36) noted that 57 of 356 cases showed prominent lymphoid hyperplasia; 44 or 78.5% of these appendices had

a raised intraluminal pressure. Pressures in 100 appendices were examined and 44% of those which were increased were due to the hyperplastic lymphatic tissue. Wangensteen and Dennis (75) admitted that this tissue is one of the factors which may be responsible for appendiceal obstruction. McCallig (76) concurs with them. However, Wangensteen's group places principal emphasis on the presence of fecaliths.

That fecaliths are not the sole factor is indicated by their absence in a very significant percentage of cases; by the fact that there is a slight predilection of the disease for males; and there seems to be an environmental factor related to the incidence of appendicitis. The assumption is that just as a fecalith may obstruct the lumen so may lymphoid tissue. If this is recognized, then many pathological reports of "normal appendix" must be reconsidered.

The relationship between upper respiratory infections, previous attacks lymphoid hyperplasia and appendicitis has been nicely summarized by Gray and Heifetz (71), Lansdown and Williamson (77), and Bohrod (78). The first mentioned writers support Aschoff's theory of pathogenesis, whereby infection spreads from the depths of the mucosal crypts to the walls of the organ. However, they further state that to begin with, stasis in the crypts is caused by obliteration of the lumen with lymphoid tissue. The germinal centers of this tissue enlarge in response to stimuli whether it be internal or external as stated by Bohrod. Stasis leads to anoxia, necrosis

and ulceration of the epithelium. Microscopic findings are of all degrees from distal luminal distention, infiltration of the walls to suppuration and gangrene.

This is the same manner in which a fecalith may cause pain and inflammation through obstruction, raised intraluminal pressure and peristalsis. It also explains previous attacks varying with the degree of occlusion. Smith (79) 1924, Southam (35) 1928, Malloy Jason and Drew (36) 1945, Stuekey (37) 1950, Poynton (80) 1950, and Weeder (34) 1951, feel that the differential diagnosis between mesenteric adenitis and acute appendicitis is academic and that the treatment of choice in each is appendectomy. Malloy, Jason and Drew feel this to be a conservative procedure and warn against progression of symptoms in the event that a closed loop obstruction is in progress. Weeder states that 75% are cured of further attacks.

Hwang and Krumbhaar (10) studied the appendices of 300 individuals of all ages who had died violent deaths. They compared the weight of the appendix with the age of the individual. It was found that the percent of lymphoid tissue and its absolute weight were greatest in the first decade and that it gradually diminished from then on. Shiota (81) quoted by Gray and Heifetz (71), stated that the organ grows in size only slightly from birth to adolescence. Hwang and Krumbhaar also noted that throughout all age groups, females were found to contain less of this tissue in the organ than the male. This would explain the slight predilection of males for inflammation

of the organ. Contrary to this Poynton (80), in reviewing 239 cases of hyperplasia in adults, found 139 of them to be females. Of the 123 cases here presented there were 62 males and 61 females. However, Bohrod (78) compared the work of Hwang and Krumbhaar with the age and sex incidence of appendicitis and found that they corresponded very well. In addition, he pointed out that it is the relative thickness of the tissue in comparison to the diameter of the lumen that is of prime importance. He stated that the highest incidence of appendicitis is in the second decade when the muscularis has reached sufficient size to narrow the lumen. Thus there is a correlation between the age and sex of a patient versus the weight of lymphoid tissue and the size of the appendiceal lumen.

COMPLICATIONS

There were four cases of severe paralytic ileus; two followed incision and drainage of abscess without appendectomy. One occurred as a result of conservative treatment after the diagnosis of diffuse peritonitis had been made. The other was the result of pelvic abscess which was incised and drained per rectum 24 days after onset of illness and 14 days after admission.

There was one case of intestinal obstruction following abscess drainage and appendectomy. Obstruction occurred two years after surgery. One child was treated conservatively for abscess and obstruction. He was dismissed in good health and lost to our records. One child entered in moribund condition; treated with fluids, suction, etc;

Wetzel enterostomy second hospital day; appendectomy fifth day. Another child had peritonitis and the wound was closed without drainage. An abscess formed on seventh postoperative day with wound drainage for two months due to cecal abdominal fistula. This was excised with complete relief at two months.

There was one case of severe wound infection which cleared on antibiotics in two weeks.

SUMMARY

Two hundred eighty-four patients ranging in age from nine months to twelve years were operated for appendicitis. There were no deaths.

Race, sex, age and seasonal incidences are recorded, and a statistical analysis of the signs and symptoms of the large series recorded in the literature are tabulated.

Various methods of treatment in relation to morbidity and mortality are analyzed and conclusions drawn. Comparison of mortality rates with pathologic types of appendicitis and treatment utilized are tabulated from the larger series recorded from 1921 through 1953.

Lymphoid hyperplasia was noted to be a factor in the formation of appendicitis in 44.3% of the 284 cases.

CONCLUSIONS

Appendicitis is the most common acute abdominal lesion in infancy and childhood. It occurs infrequently under the age of three years and is infrequently found in negroes.

A definite seasonal occurrence during spring, fall and winter was noted. Associated upper respiratory infection was noted in 61.3% of the patients.

Pain and tenderness are the most outstanding findings.

Nausea and vomiting, abdominal guard and rigidity were noted in less than one-half of the cases.

The McBurney incision is associated with less morbidity and mortality.

Surgery performed as soon as possible through a McBurney incision and with appendectomy whenever possible is the procedure of choice. When properly placed, drains decrease postoperative morbidity.

The greatest single factor contributing towards decreased mortality has been earlier hospitalization and treatment.

There is a definite relationship between upper respiratory infections, lymphoid hyperplasia of the appendix and appendicitis. Infestation with *Enterobius vermicularis* is a mechanical factor in the etiology of appendicitis just as fecaliths and lymphoid hyperplasia are.

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PART II

HYPERTROPHIC PYLORIC STENOSIS

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HYPERTROPHIC PYLORIC STENOSIS

The most common condition requiring surgical therapy in infancy is hypertrophic pyloric stenosis. Between April, 1948 and December, 1953, 131 infants had pyloroplasties performed at Childrens Memorial Hospital. The purpose of this paper is to report the existing data obtained from these records.

INCIDENCE

The overall incidence has been accurately determined in countries such as Sweden and Great Britain where socialized medicine exists. In Goteberg, Sweden, Wallgren (1) found that the condition occurred in 4 out of every 1,000 births with an incidence of one in 154 male and one in 770 female births. Davison (2) and MacMahon, Record and McKeown (3) noted an incidence of 3 per 1,000 in Great Britain.

In this series of cases 108, or 82.4%, were males. This is entirely out of proportion to the occurrence of male and female births, and as yet, is unexplained. Szilagyi and McGraw (4) presented a 50-year review of the literature. They noted that reported series record from 72.9% to 100% males with an average between 80% and 95%. They noted an occurrence of from 50% to 60% in first born children.

The incidence in the various races and countries is difficult to evaluate. Most reported series come from Anglo-Saxon countries.

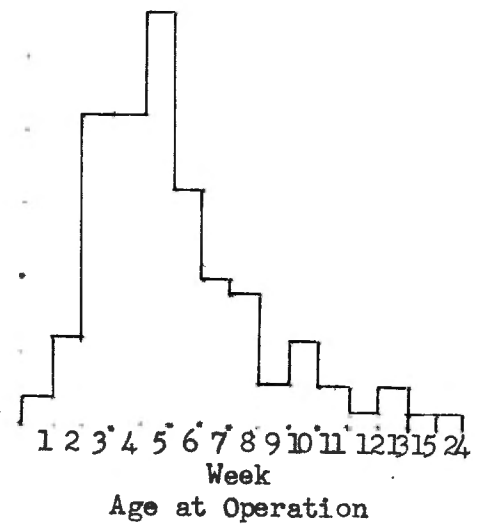
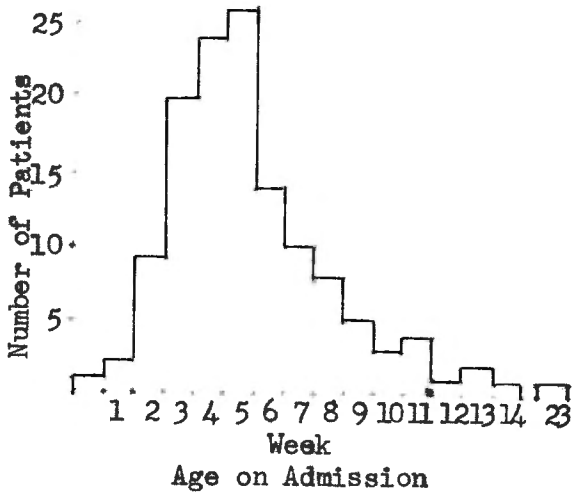
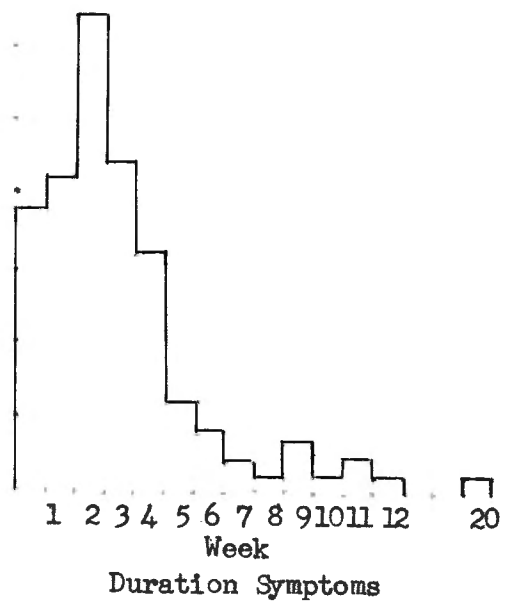
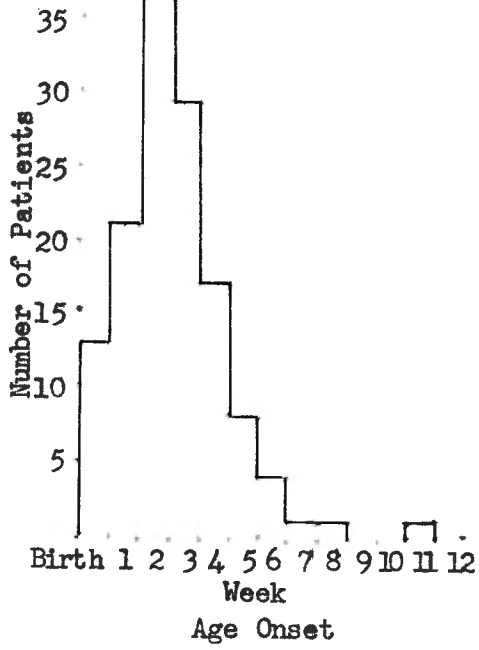
It is rarely reported in Turkey and infrequently from Italy. Donovan (14) noted a slight predominance among Jewish families. Since the incidence is always based on published reports, no definite statement can be made as to its actual occurrence. Some locales may not be cognizant of the disease. However, it can be stated with some assurance that it is infrequently encountered in negroes. One patient in this series was of that race; Ladd, Ware and Pickett (12) had none in 380 cases; Donovan (14) noted an incidence of 2%.

There is a tendency, though not strongly marked, for more than one case to occur in the same family. Grimes, Bell and Olney (18) noted this in 14 of 113 cases. A family history was noted in 9 of Schaefer and Erbes' (16) 232 cases. In Robertson's (8) 402 cases, there were 12 sets of twins, an incidence of 1 in 36.3 cases. He quoted Sheldon (21) who found 1 in 43.4 in twins. Comparative occurrence of twinning in the two localities was 1 in 80 births. Nelson(27) states that only 2 cases of monovular twins have been reported in which only one of them had pyloric stenosis.

According to MacMahon, Record and McKeown's extensive study (3), there is no increased incidence of congenital abnormalities in these patients. In this series 3 patients had inguinal hernias and 1 had an umbilical hernia.

The relationship between age at onset of symptoms, age at hospital admission, duration of symptoms and age at operation is presented in Graph A. It was noted that the onset of symptoms was

GRAPH A HYPERTROPHIC PYLORIC STENOSIS



more likely to occur during the second and third weeks of life. Of 131 cases 36 or 27.5% experienced vomiting during the second week, and 29 or 22.1% during the third week. Symptoms were present from birth in 13 or 9.9%. One case was noted to begin on each of the second, third and fourth days of life. The average of onset was 2.7 weeks. Szilagyi and McGraw (4) stated that the average age of onset in the literature was from 21 to 28.5 days and concluded that the disease rarely commences after the third month.

In comparison with the age of onset 24 or 18.3% were admitted to the hospital during the fourth week and 26 or 19.9% entered during the fifth week of life. The average age on admission was 5.5 weeks. Average duration was 3 weeks. Age at surgery was therefore 5.7 weeks.

DIAGNOSIS

As stated by Gross (22): "The symptoms are all indicative of a high obstruction and of serious loss of body fluids and electrolytes especially hydrochloric acid." According to Ladd and Gross (9), the five cardinal symptoms and signs are as follows: projectile vomiting, weight loss and dehydration, scanty stools, epigastric peristaltic waves and a palpable pyloric tumor. Comparison of reported clinical observations is tabulated on Table I.

Ladd and Gross (9) presented the usual history with onset of vomiting seldom before the ninth or tenth day of life and usually

TABLE I. HYPERTROPHIC PYLORIC STENOSIS: CLINICAL OBSERVATIONS

Author	Year	Cases	% Males	First Born	Week			% Palpable Tumor	% Gastric Waves	% Scanty Stools	Contrast Studies	First p.o. Feeding	% Duodenal Perforation	% Evisceration	% Wound Infection	% Reoperated	No. Deaths	% Mortality
					Emesis Onset	Emesis Duration	Age on Admission											
Abt & Straus (5)	1925-1926	22	72.9		2		25	100	7.4							7	3	
Lanman & Mahoney(6)	1915-1931	425	84.7				4		15		2 hr. (3)	.71				27	6.3	
Norris (7)	1927-1932	100	89		3	2.5	5.5	37	94		6 hr.						6	
Robertson (8)	1914-1939	402	81.9	51.8							4 hr.					52	12.9 3.6% mort. last 5 yrs.	
Ladd & Gross (9)	1915-1939	765					4-6	95		20 in last 3/2	Stat. (14)	1.8				27	3.6 .56% mort. last 3 yrs.	
Meredith (10)	1931-1939	137	80		3			88.3	97							9	6.5	
Williams (11)	1928-1941	400														47	11.7 1928-1938 - 15% 1938-1941 - 2.8%	
Ladd, Ware and Pickett (12)	1939-1945	380	85	55				98			Stat. (12)	2.3	52	3		4	1 R. U. Q. Grid incision	
Akin & Forbes (13)	1933-1944	147	81.7	53	2-3			76		115	2 hr. (8.2)					8	5.4 4 died before surgery	
Donovan (14)	1937-1946	245	84		2-5							.41					.8 Right Rectus incision	
Benson (15)	1948	292															.7	
Schaefer and Erbes (16)	1924-1947	232	86	43				63	83	75	1 hr. (2)	9		5.2	2.1	9	3.8 No deaths in last 172 cases	
Giuseffi and Sutton (17)	1930-1947	200	86	45	3	2	5				6 hr. (13)	6.5	0	1.5		4	2 Right Rectus incision	
Grimes, Bell and Olney (18)	1930-1950	113	83.1					72	100								.9	
Wood & Smellie (19)	1947-1949	300			3.3		5.8									4	1.3	
Baker (20)	1919-1949	329	80	64.5	2-3			74	98	55	Stat. 61%	23 7%	2.4 (8)	3.6	.6	13	3.9 Right Rectus 80%	
This Paper	1948-1953	131	82.4		2.7	3	5.5	25.2	77.9	33 cases 25.2%	Stat. 51.1%	(17) (1)	12.9 (1)	3.1	1.5	0	0	

not until the second week. The problem may be one of intermittent regurgitation at first, but it progressively becomes projectile after almost every meal. The vomitus contains no bile. The infant seems always hungry and nurses eagerly even after vomiting. Stools become progressively less frequent. As starvation continues there is failure to gain weight or weight loss. Dehydration becomes apparent as evidenced by wrinkling of the face, neck and extremities. If severe, alkalosis may give hyperpnea.

Physical examination may reveal a normal appearing child, but in advanced cases signs of weight loss and dehydration, as evidenced by poor tissue turgor, wrinkling of skin, sunken eyes and emaciation, may be apparent. There may be epigastric distention. Examination following oral feeding may elicit projectile emesis following the appearance of epigastric waves passing from left to right. Palpation of the pyloric tumor is said by Gross and his associates (9) (12) to be best elicited immediately following an emesis. When found it is pathognomonic of pyloric stenosis. A palpable tumor was noted in 25.2% and peristaltic waves were seen in 77.9% of the patients at Childrens Memorial Hospital. Blood was noted in the vomitus of only one patient in this series. Flanagan (23) recorded an incidence of 26.3% of 72 patients; Wood and Smellie (19) noted 8.4% of 320 patients; Guiseffi and Sutton (17) found a hematemesis incidence of 3% and a melena incidence of 3.5%.

DIFFERENTIAL DIAGNOSIS

Pylorospasm is the main diagnosis to be differentiated. Classically symptoms are intermittent with periods of well-being. It responds to phenobarbital and atropine derivatives. Onset is usually later and there is no male preponderance.

Intra-cranial injury presents vomiting without relation to meals and is usually present from birth. The child may show cyanosis, failure to nurse, convulsions, irregular pulse and respirations.

Intrinsic intestinal obstruction is usually characterized by emesis from birth or the first week of life. Vomitus usually contains bile and may contain feces.

Ladd, Ware and Pickett (12) include cardio-esophageal chaliasia in their differential. It is characterized by persistent vomiting, but other signs such as waves and tumor are lacking. Upper gastrointestinal studies show the cardia to be in a constant state of relaxation. Resting the child in a semi-upright position decreases the emesis problem.

Extrinsic congenital obstruction due to incomplete rotation of bowel may cause vomiting in the early weeks of life, but it usually contains bile and no tumor is palpable. X-ray studies are helpful.

Improper feeding is a very common cause of vomiting in infancy. History of the type of formula, length and manner of feeding are helpful. Hospital observation with proper formula and feeding regimen often brings about cessation of symptoms.

DIAGNOSTIC AIDS

Barium, iodochlorol or lipiodol studies were done in 33 or 25.2% of the cases presented here. The dangers and disadvantages of giving infants barium are referred to above under general considerations. According to Ladd, Ware and Pickett (12), when the tumor is palpable, X-ray studies are unnecessary; however, these men are unusually successful in palpating the pyloric tumor (98%). In general, those authors that find palpation of the tumor relatively easy find it infrequently necessary to utilize contrast studies. (Ref. 6, 10, 12, 18, 20, 24.)

Conversely those who have poor results palpating the hypertrophied pylorus find less contraindication for such studies. In this series much discretion was used regarding utilization of contrast medium. Only 25.2% received barium, lipiodol or iodochlorol even though a palpable tumor was noted in an equal number. Adequate history, observation of the patient and visualization of epigastric waves (seen in 77.9% of cases in this series) were deemed most important in making the diagnosis. It is to be remembered that a simple flat plate of the abdomen showing a large dilated gas-filled stomach with little gas beyond the pylorus can be of great help.

PREOPERATIVE CARE

In conjunction with early surgery adequate preoperative and postoperative care have been the most important factors in reducing

the mortality in this disease.

The aims of preoperative care were presented quite well by Akin and Forbes (13). They are: 1) restoration of normal electrolyte and fluid balance, 2) amelioration of malnutrition and 3) control of complicating infections. The first two aims are accomplished by the following measures: correction of alkalosis, hypochloremia and dehydration. Oral feedings are continued. They suggest using 10% glucose in saline or Ringer's in the amount of 20 cc. per kilogram by the intravenous route and an average of 100 cc. per kilogram per day of Ringer's by the subcutaneous route. Gross (22) recommends intravenous 10% glucose in water in the amount of 10 cc. per pound and a hypodermoclysis of physiologic saline equalling 15 cc. per pound of body weight every morning and evening and right before operation unless dehydration is moderate. In that event, only the intravenous route is utilized. When proper instruments are not available, he suggests the subcutaneous administration with hyaluronidase of one part physiologic saline and one part 5% glucose water in an amount not exceeding 10 to 20 cc. per pound twice daily. In this report 85.5% received preoperative fluids. The type most often used was 2½% glucose in ½ strength Ringer's solution.

Concerning saline, Mateer (25) warned that the hypotonic solution was preferred due to the immaturity of the kidneys in these patients.

If extreme alkalosis exists with or without tetany, stronger

measures are in order. Hartmann (26) recommended giving the following: Intravenous 5% calcium chloride in the amount of 1/4 cc./Kg.; 30% carbon dioxide and 70% oxygen; turn from kidney to liver function by giving a single dose of 30 cc./Kg. of isotonic or 1/6 M ammonium chloride slowly (preferably by hypodermoclysis to insure slow administration). It may also be added to Ringer's to make 1/12 M ammonium chloride in 1/2 strength Ringer's.

Flanagan (23) presented the following calculation for daily fluid requirements:

$$\begin{aligned} \text{Surface area in square meters} &= (\text{wt. in Kg.})^2 \times .1 \\ \text{Basic fluid requirement} &= 2400 \text{ cc./sq. meter/24 hour} \end{aligned}$$

He and Nelson (27) state that the approximate requirement is 150 cc./Kg.

When the child is hydrated Akin and Forbes (13) suggest relief of hypopotassemia and anemia; augmentation of liver glycogen stores. The amount of blood given at any one time should not exceed 20 cc./Kg. Gross (22) feels that a count below four million is indication for transfusion. In this series 7 patients (5.3%) received blood prior to operation and 11 (8.4%) after surgery. Amigen 3.3% and 3.3% glucose in 1/3 strength Ringer's (33% Ringer's) may be used in the amount of 100 cc./Kg./day.

Vitamin C, 25 mg. daily, may be incorporated in the parenteral fluids to aid wound healing.

OPERATIVE PROCEDURE

There is no place for medical treatment in this disease. Surgical mortality remains high in countries such as England and Sweden. There are many reasons for this. In the literature from these countries indications for surgery are appalling. Indications given by Todd (28) are failure of a seven-day medical trial and patients admitted in moribund condition. Jacoby (29) listed those infants suffering severe vomiting, hematemesis, severe dehydration, uremia or tetany.

Another factor seems to be that surgeons skilled enough for the procedure are not plentiful. Also, gastroenteritis is high on the causes of death list. Mackay's (30) discussion concerning medical treatment is a good evaluation. He states: "The pylorus will open up spontaneously in time and the child will recover if he does not die in the process."

The operative procedure of choice was originated by Fredet and improved upon by Ramstedt.

Premedication is unnecessary in these individuals unless one wishes to give atropine to decrease mucus secretion. The anesthesia of choice is open drop ether. It was used alone in 69 of the cases in this series; combined with vinethene in an additional 34 cases. Local anesthesia was utilized alone in 18 cases; with ether in 8; with vinethene and ether in 1 case. Disadvantages of a local are that wound healing is sometimes delayed and an addition of a general

anesthetic is often required. Seconal was used alone in the remaining case. In 108 patients where a general anesthetic was used, the average duration of administration was 33 minutes.

The incision used most often was the right rectus in 71 or 54.2%. A right rectus with transverse incision of the posterior sheath was utilized in 25 or 19.1%; a transverse in 19 or 14.6%; a gridiron in 12 or 9.2%; para-median in one case; and right medial rectus in two cases. Wound dehiscence and evisceration occurred once. A para-median incision had been used. The diagnosis had not been definite; epigastric waves were noted only once and no tumor was reported as being palpable. The admitting complaints had been vomiting with occasional hematemesis and bloody stools. Barium studies were not conclusive.

The duodenum was perforated in 17 or 12.9% of cases. There were no complications; slightly increased postoperative temperatures were noted in only three cases. A moderately decreased incidence of postoperative vomiting was noted.

The average operating time was 28.2 minutes. This is similar to Baker's (20) 27 and Guiseffi and Sutton's (17) 26 minutes. Abt and Strauss (5) reported 12 to 15 minutes.

Two cases were re-operated due to excessive postoperative emesis. One was three weeks after first surgery; the previous duodenal incision was seen to be markedly fibrosed. Five wound infections occurred. Comparison of these findings with those noted in the literature is tabulated on Table I.

POSTOPERATIVE CARE

Considerable debate exists concerning the cause of persistent postoperative vomiting. Szilagyi and McGraw (4) listed the following causes presented in the literature: disruption of the pyloric mucosa, central nervous system excitability, incomplete division, kinking of duodenum by dilatation of the stomach. They state that the most uncontroversial supposition presented is that since the infant has been vomiting for two or three weeks, a period of physiologic readjustment is required. I feel that, physiologically, gastric distention and gastritis causes hypersecretion of mucous cells. Many times this secretion is quite tenacious and it is understandable that it takes time for the hypersecretion to subside. MacGrae, Gibson and Coles (31) state that the effect of long standing gastritis and distention is minimized by reducing feedings and substituting parenteral fluids. They quote Wood and Smellie (19); Bell, Grimes and Olney (18); in this respect. They further state that Ian (32); Ward, McQuaid and Porritt (33); Grimes, Bell and Olney (18); Frazier and Warfield (34); Schaefer and Erbes (16) believe strongly that inadequate division of the duodenal muscle fibers is the answer. McLanahan (35) proposed passing a number 10 or 12 F catheter through the pylorus following incision to determine patency. It would also be of value following insertion of sutures when perforation is noted. MacGrae, Gibson and Coles (31) add adhesions to the list and postulate an unusual tendency of the muscle fibers to proliferate.

They found two cases requiring reoperation. In each the pylorus appeared typically hypertrophied as at first surgery.

Szilagyi and McGraw (4) speak contrary to this and say that those who deny that inadequate division is the cause find that at reoperation the incision is grossly adequate. They therefore postulated two explanations. One is that nerve pathways to the area had not been adequately severed. Secondly, the pyloric sphincter is not included in the incision in a certain portion. It does not partake in the hypertrophy, and thus remains hidden but provides continued resistance. They support these postulations by stating that the second operation invariably consists of widening and enlarging the original incision with prompt relief of symptoms.

Faber and Davis (36) presented evidence that gastric peristalsis is greatly depressed for several hours after surgery. As a result, food either remains unpropelled or is vomited. They related the depression to postoperative vomiting and distention and proposed beginning oral nutrition twenty-four hours after surgery. These men have few followers except in the case of accidental perforation.

In those cases where no reoperation was required, I have chosen an arbitrary system for classification of emesis. Regurgitation of a whole feeding or emesis of 25 cc. or more was recorded as an instance of postoperative vomiting. My classification is as follows: Grade I -- no emesis; Grade II -- 8 or less instances of emesis; Grade III -- 10 or more instances with or without projection; Grade IV

fifteen or more instances with the same reservations. This method was considered more conclusive than the number of days in which vomiting was noted. In many instances there was considerable variation in the onset and duration of emesis. A child would have difficulty for 2 or 3 days; nurse with ease for 24 to 36 hours and then have resumption of feeding difficulty; or he might have no difficulty for 1 or 2 days and then begin vomiting.

The incidence of postoperative vomiting was as follows:

Grade I:	23	(17.55%)
Grade II:	50	(38.15%)
Grade III:	24	(18.32%)
Grade IV:	34	(25.98%)

The following authors refer to such incidence tabulations but give no classification for comparison: Schaefer and Erbes (16); Grimes, Bell and Olney (18); and Baker (16); and Vance (37).

An effort has been made to determine the cause of post-surgical feeding problems and to evaluate the mechanical procedures used to alleviate the problems. I have recorded by gross methods the relationship of emesis to the following: duration and type of anesthesia; duration of the surgical procedure; accidental duodenal perforation; the onset of oral feedings; the frequency and timing of postoperative stools; and the efficacy of giving enemas and lavaging the stomach.

Admittedly, all factors are not equal and there is great variation from patient to patient. There were 18 surgeons and probably an equal number of pediatricians responsible for 131 patients. Since the cases were unequally divided among these men, no definite

conclusions can be drawn as regards the perfection of one man's technique over another.

The data presented is abstracted from hospital charts and in no way is meant to be critical. It is my desire that the information may, in part, assist in the care of those patients yet to be operated upon for pyloric stenosis.

The average duration of anesthesia was 33 minutes. In 52 instances this time was equalled or exceeded. The average length of the surgical procedure was 28.2 minutes. In 63 instances this time was equalled or exceeded. Gradation of emesis incident to anesthesia, surgical duration above the average time, and to the 17 instances of duodenal perforation is recorded on Table II.

TABLE II. PYLORIC STENOSIS: CORRELATION OF EMESIS WITH TYPE AND LENGTH OF ANESTHESIA, SURGICAL PROCEDURE AND PERFORATION

Grade of Emesis	I		II		III		IV	
	Number	%	Number	%	Number	%	Number	%
All cases--131	43	17.55	50	38.15	24	18.32	34	29.98
Duration anesthesia 33 minutes or more--52	10	19.23	20	38.46	7	13.46	15	28.80
Local anesthetic--18	3	16.66	10	55.55	3	16.66	2	11.11
Duration surgical procedure 28.2 minutes or more--63	16	25.39	27	42.85	8	12.69	12	19.04
Perforation--17	4	25.51	6	35.39	2	11.76	5	29.4

It is evident from the results recorded on Table II that lengthy anesthesia in itself does not appreciably alter emesis difficulty. However when compared with local anesthesia, there is increased

incidence of grade IV vomiting. Physiologically, this is to be expected and must be weighed against possible mechanical difficulties during surgery and danger of poor wound healing.

A decrease in the observation of grade III and grade IV vomiting is noted when the length of the surgical procedure exceeds the average. This may indicate that more time is spent insuring adequate distal muscle separation.

Accidental duodenal perforation results in a slightly decreased incidence of postoperative emesis. Sutton (17) concurs with this finding. In addition there were no cases of peritonitis

POSTOPERATIVE GASTROINTESTINAL PHYSIOLOGY

There are almost as many regimens of postoperative feeding in the literature as there are articles. Comprehensive examination of these articles indicates that frequent feedings of increasing amount is the method most often used.

The time of onset of feedings was recorded in 123 cases. Relationship to emesis difficulty is recorded in Table III. No definite conclusions can be obtained from Table III.

In regard to normal bowel activity 47 cases revealed a definite gross relationship between the number and timing of stools and emesis difficulty. The relationship was equivocal in all other cases. In 19 of the 47 patients alleviation of emesis was noted following the onset of three or more stools per day. In some of these cases the stool-emesis time relationship was also positive. Defecation of

a normal sized stool was followed by over six hours of relief from emesis. The other 28 cases displayed no relief.

In seven instances an enema was given postoperatively. In each case definite alleviation or complete recession of vomiting followed this procedure.

Notation of lavage was made in 21 cases. By relieving the patient of the thick tenacious gastric mucus 16 of the infants had alleviation or complete cessation of their feeding problem.

TABLE III. PYLORIC STENOSIS: RELATIONSHIP OF POSTOPERATIVE EMESIS TO THE TIME OF FIRST FEEDING

Hour of First Feeding	emesis									
	Cases	% of Total	Grade I	%	Grade II	%	Grade III	%	Grade IV	%
on awakening	67	54.47	10	14.92	22	32.83	18	26.86	17	23.88
2	8	6.50	3	37.5	4	50			1	12.5
4	16	13.01	4	25.00	6	37.50	2	12.50	4	25.00
6	9	7.32			4	44.44	1	11.12	4	44.44
8	8	6.50	2	12.5	2	12.5	1	12.5	3	37.5
12	6	4.88			5	83.33	1	16.66		
16	2	1.62			2	100				
18	1	.82					1	100		
24	6	4.88	3	50.00	1	16.66			2	33.33
Total	123		22		46		24		31	

POSTOPERATIVE PARENTERAL FLUIDS

It is obvious that in the average case caloric, fluid and electrolyte requirements are not met by oral feedings during the first 36 to 48 hours. Parenteral fluids were utilized in 105 (80.2%) cases. Blood was given to 11 (8.4%).

COMPLICATIONS

Postoperative vomiting, wound dehiscence and evisceration, wound infection and accidental duodenal perforation have been referred to above. Most writers believe that duodenal perforation is only serious when not recognized. Lanman and Mahoney (6) noted 3 cases; one died of peritonitis. Ladd and Gross (9) recorded 14 cases; 3 died, one from peritonitis. Baker (20) recorded 23 patients; one died eight hours after surgery from over hydration.

Two patients required a second operation due to excessive vomiting. The original surgery for one of these infants had been performed elsewhere.

There was one case of viral pneumonia. Vinethene and ether anesthesia had been used. Four cases of interstitial pneumonitis occurred; two followed ether; one followed vinethene and ether and one followed ether and local anesthesia.

One child was discharged 263 days following admission. Intestinal obstruction with liver disease and jaundice occurred after surgery. A large 2.5 cm. by 1.75 cm. pyloric tumor had been encountered. Medical management was utilized after pylorotomy.

The average hospital stay was 13.4 days. Average number of postoperative days was 9.6.

MORTALITY

There were no deaths in 131 cases. This is attributed to well supervised care before and after surgery. It is obvious that mortality

rates in the United States are lower than those abroad. Contributory factors are: cases are operated earlier and no medical trial is given; experienced surgeons are more readily available; complicating infections such as gastroenteritis are greatly reduced due to better hospital care, sanitation and supervision.

SUMMARY

The clinical observations recorded at Childrens Memorial Hospital are compared with those of the larger series reported in the literature.

A graphic relationship of age of onset of symptoms; age at hospital admission and age at surgery is given.

Methods of preoperative and postoperative care are presented.

Explanations for persistent postoperative emesis are analyzed; and a system of classification of vomiting is presented. The incidence of emesis in 131 cases is given and its relationship to accidental duodenal perforation, duration of anesthesia, duration of surgical procedure and time of first oral feeding is recorded.

An attempt is made to evaluate the value of lavage, enemas and return of normal bowel movements after surgery.

CONCLUSIONS

From April, 1948 through 1953, 131 infants underwent pyloroplasties without a single death.

The incidence of the disease is approximately three in 1,000

live births, 80% are males and 50% are first born children. Occurrence in negroes is very low. There is a slight familial tendency, and no increased incidence of other congenital abnormalities.

Onset is most likely to occur during the second to the third week of life, but may occur at any time from birth through the second month.

When the five cardinal signs and symptoms are present, contrast x-ray studies are unnecessary and harmful. A palpable pyloric tumor is not necessary for a diagnosis without x-ray. Adequate history and observation are sufficient.

Restoration and maintenance of normal electrolyte and fluid balance, amelioration of malnutrition and control of complicating infections are paramount in reducing mortality.

Anesthesia of choice is open drop ether. By comparison with local anesthesia it is followed by an appreciable increase in postoperative vomiting. The use of a local often produces mechanical difficulties, increases the length of the procedure and may hinder wound healing. Pneumonitis may follow use of a general anesthetic. These factors must be weighed.

A surgical procedure lasting longer than the average of 28 minutes is followed by decreased postoperative emesis. This may be due to more adequate separation of the distal pyloric musculature. Mucosal perforation in this region is followed by less postoperative emesis.

Comparison of emesis incident to varying methods of oral feeding is equivocal. However, compared with the emesis problem noted in 131 patients, the 67 patients given oral fluid immediately upon awakening showed moderately worse vomiting.

The postoperative stool-emesis time relationship in 19 of 47 cases displayed definite relief from emesis. Where utilized, an enema was followed by relief from vomiting. Lavage before feeding afforded relief in 16 of 21 patients.

Excellent pediatric, surgical and nursing care is responsible for the low mortality rates in this hospital.

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PART III

INTUSSUSCEPTION

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INTUSSUSCEPTION

Through December, 1953, the records of Childrens Memorial Hospital revealed 42 cases of intussusception. It is the most common cause for emergency abdominal surgery in children under two years of age.

ETIOLOGY

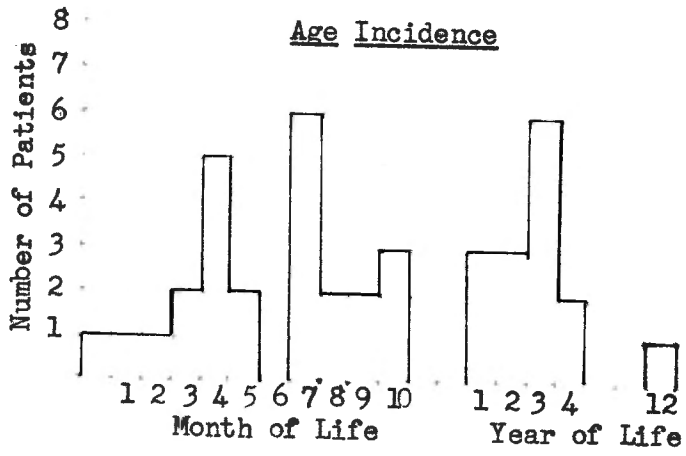
A definite demonstrable etiologic agent was noted in three cases. Two were due to a Meckel's diverticulum and the other was caused by a lymphosarcoma of the cecum. In twelve other patients notation was made of lymph nodes as large as 2.5 cm. by 7.5 cm. in size occurring at the ileo-cecal junction. Intussusception recurred nine months later in one of these patients. Large terminal ileum nodes were again present.

In Gross' 702 cases (1) etiologic agents were found in only 6%. They were as follows: Meckel's diverticulum 32; intestinal polyp 5; lymphoma 2; duplication of terminal ileum 3; hematoma of ileum 1. He further states that since most cases occur from the fourth to the tenth month, change in diet may possibly be a factor. In addition he lists acute enteritis and occasionally allergic states as agents.

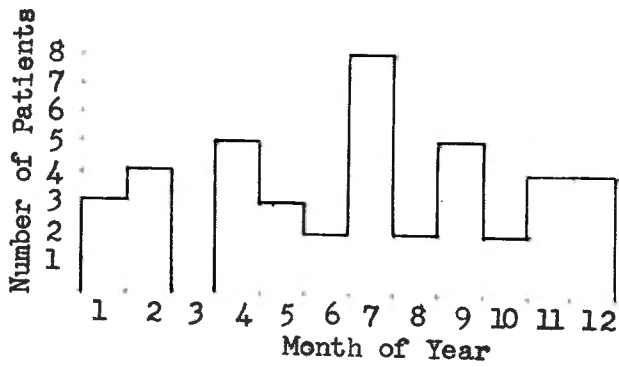
INCIDENCE

All of the patients presented were of the Caucasian race. There were 25 males and 17 females. Twenty-eight were under one

GRAPH A INTUSSUSCEPTION



Seasonal Incidence



year of age; 32 were under two years of age. The youngest patient was two days old and the oldest was twelve years. Gross (1) states: "The peak incidence occurs from the third to the eleventh month." Age incidence and monthly occurrence of the condition at Childrens Hospital is recorded on Graph A.

DIAGNOSIS

The first symptom was colicky abdominal pain in 21 patients; vomiting in 18; diarrhea in 2 and bloody stools in 1.

Pain was noted during the course of the disease in 27 patients; vomiting in 29; bloody stools were noted in 30.

On physical examination 32 patients were well developed and well nourished. Four patients were malnourished. One of these was an achondroplastic dwarf, and another had fibrocystic disease of the pancreas. Only one other congenital abnormality was recorded--a child with mongoloid tendencies. Six patients were shocky and 14 were dehydrated on admission. The average admission temperature of the 42 patients was 100.3^R. Seven patients displayed abdominal distention. An abdominal mass was palpable in 23 cases; in 6 instances it was tender. Abdominal tenderness was elicited in only eight patients. Location of the abdominal masses was as follows: right upper quadrant, 10; right midline, 3; right lower quadrant, 4; left upper quadrant, 2; left lower quadrant, 4. In two of the latter cases a portion of the mass had prolapsed from the rectum, and in one other case, it was palpated during rectal examination. Dance's sign

was recorded in only two instances.

A flat plate of the abdomen was taken of 12 patients. In 5 instances no diagnostic help was obtained. Thirty patients received barium enemas. Results were negative for 7 patients. One of these patients underwent surgery at which time evidence of a reduced ileo-colic intussusception was noted. Of the 6 others 3 had had enemas administered to them before entering the hospital.

For 27 patients the average duration of symptoms before admission was 33.25 hours. The average duration before surgery was 39.5 hours. Four patients had symptoms of 5 days duration. None died.

TREATMENT

Parenteral fluids were given 18 patients and 6 received blood prior to surgery. Wargenstein suction was begun on 2 patients.

Sixteen patients had received one or more enemas by the time of admission.

Types of intussusception were recorded as follows: ileo-ileo, 2; ileo-colic, 24; ileo-ileo-colic, 4; colic-colic, 2; not stated or no surgery required, 10.

Eight of the 42 patients required no surgery. They had received enemas at home or a barium enema after hospitalization. In addition, 7 patients were noted at surgery to have evidence of previous intussusception which had reduced spontaneously during or prior to laparotomy. Fourteen of the remaining 27 patients had reducible intussusceptions at surgery. The thirteen other patients required the following additional surgical procedures:

<u>Type of</u> <u>Intussusception</u>	<u>Number</u>	
ileo-colic	3	Resection terminal ileum and ascending colon. Side to side ileo-colostomy. 1 died.
	1	Excision Meckel's diverticulum
	1	Resection 10 inches ileum. End-to end ileo-ileostomy. Died.
	1	Resection terminal ileum. Side to side ileo-colostomy. Dehiscence and evisceration on sixth day. Resutured.
	1	Mongoloid. Evidence of previous ileo-colic type. Hypertrophy ileo-cecal junction as if stenosed. Valve area incised to mucosa and mesentery ileum tacked to colon. Appendectomy. Died.
ileo-ileo	1	Resection portion ileum, end to end ileo-ileostomy with Witzel enterostomy for nutrition.
	1	Resection portion ileum and gangrenous Meckel's. Then side to side ileo-ileostomy.
ileo-ileo-colic	2	Resection portion ileum. End to end ileo-ileostomy.
	1	Resection 15 cm. ileum. Side to side ileo-ileostomy. Appendectomy. Died.
colic-colic	1	Hemicolectomy. End to end ileo-colostomy. Lymphosarcoma cecum.

The appendix was removed from 15 patients. Pathology noted was as follows: lymphoid hyperplasia, 5; lymphoid hyperplasia with acute focal appendicitis, 4; hemorrhagic appendicitis with lymphoid

hyperplasia and acute focal appendicitis, 1; vermiform appendix, 2; not stated, 2; acute diffuse appendicitis, 1.

Parenteral fluids were given 27 patients after surgery. Twelve received blood; thus 18 patients received blood prior to or following surgery. Nine patients had insertion of a Levine tube postoperatively.

COMPLICATIONS AND MORTALITY

As mentioned above, one patient suffered wound dehiscence and evisceration. Two patients had recurrence of the condition. Time span after first surgery was six and nine months respectively. One child was dismissed with evidence of encephalopathy believed due to hyperpyrexia.

Four children expired. Their case reports follow:

1. Well developed, well nourished 7½ month old white male. Onset of emesis and irritability four days prior to admission. Had a bloody stool on admission day. Was distended and dehydrated when entered hospital 98 hours after onset. Temperature 103.4^R. Surgery three hours later. Ileo-colic type. Under vinethene and ether 10 inches of necrotic ileum resected and end to end ileo-ileostomy performed. 60 minute procedure. Wangenstein suction and parenteral fluids given postoperatively. Died 3 to 4 hours after surgery.

2. Well developed, well nourished 7 month old white male. Pain, bloody stools, emesis. Entered hospital "shocky" and dehydrated 27 hours after onset. Temperature 104^R. Bilateral interstitial pneumonia present. Surgery one hour later after fluids started. 60 minute ether administration. Ileo-colic type. Resection terminal ileum and ascending colon and side to side ileo-colostomy. 40 minute procedure. Fluids, 2 pints blood, plasma, oxygen and Wangenstein suction. Developed frank pneumonia third postoperative day. Death with distention and dehydration.

3. Well developed, well nourished 5 month old female. Onset emesis 34 hours prior to admission. Then fussiness and bloody stools. Entered "shocky" and dehydrated with temperature 101.4^R. Temperature immediately rose to 103^R; then 104.6^R. Preoperative fluids given. Ether administration 89 minutes. Ileo-ileo-colic type. Markedly hypertrophied Peyer's patches (to 1.5 cm. in diameter). Ileum resected 15 cm. and side to side ileo-ileostomy. Appendectomy. Procedure 98 minutes. Postoperative Wengensteen suction and fluids. Autopsy report: shock and chemical imbalance.

4. Well developed, well nourished white mongoloid male 2 days old. Emesis bile stained fluid intermittent since birth. Admitted distended and dehydrated. Flat plate displayed small bowel obstruction. Under ether anesthesia evidence of a reduced ileo-colic type found. Ileo-cecal junction appeared hypertrophied and scarred as if stenosed. Muscle separated to mucosa and mesentery ileum tacked to colon. Appendectomy. Autopsy report: acute diffuse peritonitis associated with marked greenish exudate over appendiceal stump; myocardial dilatation and passive congestion viscera.

SUMMARY

Etiologic agents and the age, sex and race incidence are recorded. Clinical observations and the value of diagnostic aids are listed.

Type and number of special surgical procedures are noted.

Case reports of the four deaths are presented.

CONCLUSIONS

It is unusual for a definite demonstrable etiologic agent to be seen. Enlarged ileo-cecal lymph nodes may very possibly be a factor.

The condition is more common in males and occurs more often during the summer months.

A scout film of the abdomen as well as a barium enema is not always reliable.

One-half of the patients who underwent laparotomy required special surgical procedures for reduction.

The four children who died had had either a long duration of symptoms, a severe infection before surgery or a lengthy, extensive one stage surgical procedure.

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PART IV

INTESTINAL OBSTRUCTION

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INTESTINAL OBSTRUCTION

In addition to intussusception, Childrens Memorial Hospital records revealed the following types of intestinal obstruction.

<u>Congenital</u>	<u>Number of Cases</u>	<u>Deaths</u>
Intrinsic		
Atresia	7	4
Stenosis	2	1
Meconium Ileus	4	4
Megacolon	1	1
Extrinsic		
Adhesions	5	2
Band	3	0
Malrotation	5	1
Annular Pancreas	1	1
Strangulated Hernia	5	0
<u>Acquired</u>		
Volvulus	3	1
Neoplasm	2	1
Duodenal ulcer	1	0
Meckel's Diverticulum	2	0
Postoperative adhesions	4	0
Inflammatory	2	0
Total	47	16

CONGENITAL

INTRINSIC FORMS OF OBSTRUCTION

ATRESIA

1. Four day old white female. Vomiting since birth; distention; tympany; 9 oz. weight loss. Atresia lower ileum. Side to side enteroenterostomy. Had partial bowel obstruction 20 days postop. Relieved spontaneously.

2. One day old white female. Emesis every feeding brownish bile colored; distention. Scout film positive.

Atresia lower ileum. Side to side enteroenterostomy. Aspirated emesis fourth postop. day. Obstruction ten days postop. Died tenth day due volvulus, atelectasis and pneumonia.

3. White male thirty-six hours old. Emesis bile; ileus; fluid in abdomen. Paracentesis performed. Died before surgery. Atresia high ileum and adhesive band above dilated portion. Peritonitis secondary to atresia; septicemia, atelectasis, chronic passive congestion liver and spleen.

4. Four day old white female. Emesis every feeding; no stools; distention; tympany. Scout film and barium studies positive. Atresia jejunum at twenty-nine inch level and ileum. End to end jejunoileostomy. On eleventh day postop. obstruction due adhesions. Second surgery the next day. Adhesions and abscess at point of anastomosis. Ileo-cecostomy performed. Died thirteen days later. No autopsy.

5. Five day old white male. Bile stained emesis. Flat plate positive. Atresia terminal ileum. 3 cm. ileum resected and side to side ileo-colostomy. Aspirated emesis on table and death. Autopsy reported cerebral anoxia and moderate pulmonary atelectasis.

6. White female thirty-six hours old. Emesis and distention since birth. Flat plate and barium enema positive. Found dilated small and large bowel and atresia sigmoid colon. Side to side colon anastomosis.

7. White female one day old. Imperforate anus. Anal opening reconstructed by bringing blind rectal pouch to skin edges of perineal incision.

STENOSIS

1. Seven month old white male. Intermittent emesis for two to three months. Mongoloid. Barium studies positive. Partial malrotation with cecal band extending over duodenum and stenosis second and third portions of duodenum. Partial diaphragm in lumen. Longitudinal enterostomy; diaphragm excised and transverse closure.

2. Six day old white male. Emesis all feedings for four days. No mention of bile. Stenosis second portion duodenum. Gastrojejunostomy. Had partial stenosis of stoma twenty-eight days later. Continued emesis. Autopsy reported inanition, malnutrition and congenital pre-pyloric mucosal fold. Hypotheses were altered emesis reflex and congenital change of the physiological response of the stomach.

MECONIUM ILEUS

1. Three day old white male. Emesis for two days. Two cousins died of bowel obstruction as infants. Operative diagnosis of five atresias of jejunum and ileum. Jejunocecostomy performed. No stools for six days. Death on forty-first day. Autopsy findings were bronchopneumonia, peritonitis, bile stasis, chronic pancreatitis and meconium ileus.

2. Two day old white female. Emesis and no stools. Mass in right abdomen. Flat plate evidence small bowel obstruction. Ileum involved. Ileo-transversecolostomy and enterostomy terminal ileum. Died five months later of ileo-abdominal fistula and pneumonia.

3. White female sixteen and one-half hours old. Distention, emesis and no stools. Entire colon 1 cm. in diameter and filled with meconium. Hopeless. Died.

4. Three day old white female, Distention since birth; no stools; intermittent emesis. Flat plate evidence small bowel obstruction. Partial resection ileum; ileocolostomy and ileostomy performed. Died eleven days later with purulent bronchitis, diffuse interstitial pneumonia and marked inanition.

MEGACOLON

1. Four day old white male. Distended and only one stool since birth. Rectal stimulated bowels to move. Brother died of fibrocystic disease of pancreas. Diagnosis meconium ileus. At sixteen days of age onset emesis and distention. Ileostomy six days later for decompression.

Death three days later. Autopsy reported large bowel obstruction due idiopathic megacolon, interstitial pneumonitis, acute fibrinous pleuritis.

EXTRINSIC FORMS OF OBSTRUCTION

ADHESIONS

1. Seven day old white male. Constipation and distention for four days. Medical treatment of diagnosed adynamic ileus of colon. Thirty days later admitted with history of severe constipation for one week. Scout film displayed distended impacted right colon. Barium enema revealed annular constriction at recto-sigmoid junction. Found double kink of sigmoid and adhesions. Suffered emesis, fever and distention seven weeks later. Perforated sigmoid. Double-barreled sigmoid colostomy performed. When eleven weeks old had small bowel obstruction due adhesions. This was decompressed by ileostomy. Died seven days later. Autopsy reported peritonitis and gangrene small bowel.

2. Three day old white male. Distention and cyanosis since birth. Scout film displayed gastric distention. Lysis adhesions from hepatic flexure over second and third duodenum and band from second duodenum to gall bladder bed.

3. Five day old white male. Emesis or regurgitation every meal. First surgery--lysis multiple adhesions pylorus and third duodenum. Stricture retroperitoneal duodenum due superior mesenteric artery. Vessel was freed. Pyloric obstruction two days later. Jejuno-duodenostomy performed on third day. Pyloric obstruction on eighth day due breakdown anastomosis from gastric distention and adhesions from pancreatic and biliary fistula. Also wound dehiscence due pancreatic enzymes and biliary drainage. Lysis of adhesions and jejuno-duodenostomy.

4. Three day old white male. Emesis or regurgitation all feedings. Flat plate revealed gas in stomach only. Adhesions and torsion with gangrene of entire small bowel. Died after closure.

5. Five day old white female. Intermittent emesis since birth. Lysis adhesions extending about duodenum to gall bladder bed and posterior body wall.

CONGENITAL BAND

1. Seven day old white male. Regurgitation of every meal since birth with bile stained fluid. Colloidal contrast studies displayed duodenal obstruction. Severance of band compressing second and third duodenum and superior mesenteric artery freed. Eleven days later became obstructed due adhesions about second and third duodenum. Duodenojejunoscopy and lysis of adhesions performed.

2. Twenty-one day old white male. Emesis; regurgitation and gastric waves. Preoperative diagnosis pyloric obstruction. Severance of band compressing first portion duodenum.

3. Seven week old white male. History of pyloromyotomy done elsewhere eight days previous. Complaint of continued emesis. Flat plate displayed partial high obstruction. Barium studies negative. Severance of numerous postoperative adhesions and band compressing high jejunum.

MALROTATION OF BOWEL

1. White female twelve hours old. Distended at birth. Flat plate positive. Surgical findings were malrotation causing gangrene and perforation of duodenum, absence of duodenal mesentery. Peritonitis and generalized adhesions due to "old" peritonitis. Died. Autopsy findings were volvulus of small intestine, erythroblastosis fetalis and subarachnoid hemorrhage.

2. Six day old white female. Severe emesis and two stools in six days. Flat plate and barium studies done. Malrotation colon with cecal band compressing third duodenum; volvulus small bowel. Reduction and severance of band which allowed return of secum to right lower quadrant.

3. One month old white male. Intermittent emesis for eighteen days and distention. Barium studies positive. Malrotation colon with congenital band obstructing duodenojejunal junction! Severed.

4. Six year old white female. Intermittent emesis and abdominal pain. Onset last episode eight hours previous. Rectus rigidity and right lower quadrant tender. Malrotation cecum with small bowel volvulus and intra-abdominal hernia under cecal peritoneal band.

5. Four day old white female. Regurgitation all feedings and no stools. Flat plate and barium studies positive. Cecal band obstruction third portion of duodenum.

ANNULAR PANCREAS

1. Five day old white male. Emesis since birth; no stools; mongolism. Scout film showed gastric distention. Barium studies positive. Head of pancreas encircled second portion duodenum. Died. Autopsy reported auricular and ventricular septal defects; patent ductus; bronchopneumonia.

STRANGULATED HERNIA

1. Three and one-half month old white male. Right inguinal hernia since birth. Emesis and distention seventeen hours. Loop of ileum and portion of cecum in sac. Herniorrhaphy.

2. Three year old white male. Emesis of sixteen hours duration. Right inguinal hernia noted since six months of age. Contained loop of ileum. Herniorrhaphy.

3. Three week old white male. Emesis intermittent for six days and paucity of stools five days. L. M. D. aspirated blood from swelling in right scrotum. Strangulation small bowel and right testis. Severance of band at neck of sac released bowel. Orchiectomy and herniorrhaphy.

4. Four month old white male. Emesis and pain one hour. Sac contained 4 cm. of blue but viable small bowel. Herniorrhaphy.

5. Nine week old white male. Pain and emesis of three and one-half hours duration. Release of small bowel at sac neck constriction. Fergusson repair.

ACQUIRED INTESTINAL OBSTRUCTION

Part III of this paper embodies cases of intussusception.

Following are additional types of acquired obstruction.

VOLVULUS

1. Ten day old white male. Diarrhea and emesis thirty-seven hours duration. Distended. Cyst of unknown type present 10 cm. from ileo-cecal junction on ante-mesenteric border of bowel. Volvulus and gangrene of small intestine leaving three inches of viable jejunum. Jejunocolostomy performed. Died with peritonitis and pulmonary edema.

2. White female thirty-six hours old. Emesis and distention since birth. Flat plate and barium enema evidence of obstruction. Volvulus small bowel due to mesenteric adenitis. Reduction and appendectomy.

3. Six day old white male. Emesis for forty-eight hours. Distended. Scout film and barium enema evidence obstruction. Decompressed and hydrated. Surgery two weeks after admission revealed enterogenous cyst mid-ileum and small bowel volvulus. Resection of cyst section ileum and side to side ileo-ileostomy.

NEOPLASM

1. Four week old white male. History of intermittent emesis and diarrhea for three weeks. Stools occasionally bloody. Died prior to surgery. Autopsy report revealed papillary carcinoma ileum with intestinal obstruction, perforation and peritonitis.

2. Three year old white female. Abdominal pain three days. Distention and generalized rigidity. Flat plate evidence small bowel obstruction. Lymphangioma of upper ileum or lower jejunum. Side to side entero-enterostomy.

DUODENAL ULCER

1. Three and one-half week old white female. Ten day history of emesis which was occasionally projectile. Ten days later laparotomy revealed edema and hemorrhage in the wall of the first and second duodenum with generalized adhesions in this region. Gastroenterostomy performed.

MECKEL'S DIVERTICULUM

1. Three and one-half year old male. Pain and emesis intermittent seven days. Distended. Tender right lower quadrant. Acute diffuse suppurative Meckel's adherent to mesentery of ileum causing internal hernia. Resection and side to side ileo-ileostomy.

2. Eight year old white male. Intermittent pain at umbilicus and vomiting for seven years. Umbilical tenderness, distention, dehydrated. Meckel's diverticulum acted as pivot for volvulus. Longitudinal resection of diverticulum and transverse closure. Appendectomy.

POSTOPERATIVE ADHESIONS

1. Six year old white male. Appendectomy two months previous. Recurrent abdominal pain one month duration. Distended and tympanic. Scout film displayed partial small bowel obstruction. Generalized adhesions and chronic ileitis. End to end ileocolostomy.

2. Five year old white male. Intermittent vomiting eleven days. Distended. Appendectomy two years previous with abscess drainage. Barium enema negative. Decompressed. Lysis band of adhesions from mid-ileum to cecum.

3. Six month old white male. Bloody stools. Gangrenous Meckel's diverticulum resected. Obstruction three days later due to adhesions proximal to diverticulum wedge resection and hemorrhage into mesentery. Region resected and ileo-ileostomy performed.

4. Seven year old white male. Pain, nausea and vomiting following blow to abdomen three days previous. Intermittent pain, colic and vomiting since then. Splenectomy six months prior to admission. Flat plate displayed small bowel obstruction. Lysis of numerous jejunal bands.

INFLAMMATORY

1. White female four and one-half years old. Pain, nausea, vomiting for four days. Tenderness, rigidity and mass in right lower quadrant. Distended. Temperature, 99.5R; WBC, 22,400. Diagnosis of appendiceal abscess made. Improved on medical regimen. Lost to our records.

2. White female three years old. Pain, nausea, vomiting and diarrhea five days duration. Marked distension. Temperature, 100.2; WBC, 11,700. Treated with fluids, suction, etc.; Wetzel enterostomy second hospital day; appendectomy fifth day.

SUMMARY

Brief case reports of forty-seven patients suffering intestinal obstruction are presented. A total of thirty-three were of the congenital type. Division into intrinsic and extrinsic types is listed. There were fourteen deaths or a mortality rate of 41.1% in this group. Fourteen were of the acquired type. Two of these patients died. Overall mortality was 34%.

CONCLUSIONS

Only two children in this series were mongoloid. This is in contradistinction to reports in the literature of occurrence as high as 30%.

Obstruction in the very young carries a very high mortality rate. Fourteen of the sixteen deaths occurred in infants who were seven days of age or younger at first surgery. One other child was ten days old and was found to have gangrene of the entire small intestine. The last death occurred in a four week old infant with a papillary carcinoma of ileum who had suffered intermittent emesis and diarrhea for three weeks. He was moribund on admission and no surgical procedure was undertaken.

PART V

MISCELLANEOUS SURGERY

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MECKEL'S DIVERTICULUM

Childrens Memorial Hospital files contained twelve cases of Meckel's diverticulum. Eight were under 2 years of age; the others were $3\frac{1}{2}$ years; 7 years; 8 and 9 years of age.

The outstanding primary complaint of four patients was bloody stools; an equal number suffered pain, nausea and vomiting; one had umbilical fecal drainage; one had purulent to serous umbilical drainage; two complained of emesis first.

Symptoms and signs in their entirety were as follows: emesis, 9; bloody stools, 6; abdominal tenderness, 6; pain, 6; distention, 3; mass, 1; rigidity, 2.

The existence of the diverticula caused intestinal obstruction in two instances. One served as a pivot point for a volvulus and the other caused an intra-abdominal hernia by way of its being adherent to the mesentery of the ileum.

The structure formed the leading point of one ileo-ileo and one ileo-colic intussusception.

The organ was incidentally found at surgery for appendicitis in one case.

The patient exhibiting fecal drainage from the umbilicus had a patent omphalo-mesenteric duct.

The child which displayed purulent to serous umbilical drainage had the following surgical findings: numerous fibrinous adhesions from umbilicus to small bowel; several sinus tracts from ileum to

to umbilicus; dome of bladder attaching directly to umbilicus; vitelline vein extending from the umbilicus to the porta hepatis and attached to a Meckel's diverticulum measuring 2 x 1 cm. The diverticulum was not removed due to the patient's condition following excision of tracts.

The last mentioned patient suffered postoperative intestinal obstruction due to peritonitis. This was successfully treated by medical means.

One other child had intestinal obstruction due to adhesions. This occurred three days following first surgery and a resection of ileum with side to side ileo-ileostomy was necessary to relieve the condition.

Regional resection of ileum and side to side ileo-ileostomy was performed in four instances; longitudinal excision and transverse closure, two patients; transverse excision and closure, one patient; resection with oblique end to end anastomosis, one patient; wedge resection, one patient; and no excision in one patient. In addition the appendix was removed from four patients.

It is interesting to note that microscopic study of the vestigial organ revealed gastric and pancreatic inclusions in one case. Three had bloody stools as a primary complaint. The other child's illness began with abdominal pain; the bloody stools were noted later.

There were no deaths.

EXTRA-HEPATIC BILIARY DUCT OBSTRUCTION

Following are six case reports of biliary duct atresia:

1. Three and one-half month old white female. Jaundice, acholic stools and dark urine since birth. Hepatomegaly. Surgical findings were biliary cirrhosis, atrophic gallbladder, absence of cystic duct and common duct atresia. Choledochoduodenostomy around polyethelene tubing.

2. Two and one-half month old white female. Progressive jaundice since birth, occasional light stools. Surgical findings were absence of gallbladder and hepatic duct atresia. Hepaticoduodenostomy around polyethelene tubing. Stools acholic after surgery. Possible intra-hepatic atresia as well. Died six months after surgery of cerebral vascular accident?

3. Five week old white female. Jaundice and acholic stools since birth. Choledochostomy with polyethelene tube at first surgery. Hepaticoduodenostomy performed two weeks later.

4. Four month old white male. Jaundice since one week of age; acholic stools one week. Liver border at iliac crest. Complete absence of extra-hepatic bile ducts. Liver biopsy and closure.

5. Two month old white male. Jaundice since ten days old; light yellow to white stools; bright yellow urine. Partial left hepatectomy performed in effort to find biliary duct. None found.

6. Four week old white female. Jaundice and occasional emesis since first week of life. Surgery deferred three months due to viral pneumonia. At four months of age surgery performed. Complete absence of extra-hepatic ducts. Bile obtained when hilum of liver aspirated. Plastic catheter sutured here and brought out abdominal incision. Three days later hepaticoduodenostomy performed around plastic catheter. This child lived to the age of five years.

There was one case of mucus plug obstruction of the common bile duct. The child was a six week old white female. She had been

jaundiced since birth; parents had noted bright yellow urine and a gray colored stool had been noticed one month previous to admission. The common duct was not dilated and a saline flush entered duodenum. An attempt was made to inject diodrast into the hepatic duct; this failed. The child died ten days later due to severe enteritis. Autopsy findings were gas infiltration and inflammation of small bowel wall, bile stasis and bile nephrosis.

Another child was admitted with a complaint of jaundice which waxed and waned. She was a thirteen month old white girl. A cholecystogram revealed cholelithiasis. Cholecystectomy and common duct irrigation was performed. Her jaundice was still present four months later. Exploration revealed common duct stricture, probably congenital in origin. A choledochoduodenostomy was performed. One month later jaundice and dark urine still were present. Both direct and indirect van den Bergh elevated. Probable intra-hepatic obstruction.

In summary there were eight cases of biliary tree obstruction. All were of the Caucasian race. Six were females. There was complete absence of extra-hepatic ducts in three cases. One of these was closed with no further procedure. A partial left hepatectomy was performed in another in an attempt to find a suitable duct; none was found. There was no follow-up information on either of these patients. In the remaining case repeated hilar aspiration afforded successful bile return and a hepaticoduodenostomy was later performed. This child lived to the age of five years.

There were two hepatic duct and one common duct atresias. Two of them were lost to our records and one child with hepatic duct atresia died six months postoperatively.

The other recorded death occurred in a child who had a mucus plug obstruction. She lived ten days.

There was one case of chronic cholecystitis and cholelithiasis.

TRAUMA

Nine patients required emergency abdominal surgery as a result of trauma.

In seven instances the spleen was lacerated. In addition two of these patients had hematomas of the left kidney. One child suffered laceration of the liver.

Six of the above children complained of abdominal pain. Three noted shoulder pain. In one of these cases pain was bilateral. Blood pressures varied from normal to 54/34; pulse varied from 84 to 160. Abdominal tenderness was recorded in each case; involuntary muscle guard in five; rebound in one.

The average white blood count was 20,000. It varied from 10,000 to 30,000.

A flat film of the abdomen was obtained in six instances. Information secured aided in making the diagnosis in each case.

In five instances the duration of the condition prior to surgery averaged 5.7 hours. The other recorded case was 28 hours in duration.

One child also sustained a fractured humerus and skull. Another had a mid-tibial fracture.

All underwent splenectomy with the left rectus incision being utilized most often. The two kidney hematomas were left alone. There were no deaths.

The other traumatic injury was sustained by a seventeen month old negro male. He suffered an abdominal wall laceration while falling from a high chair on a broken teacup. There was evisceration of small bowel. This was cleansed with saline and returned successfully to the abdomen.

FOREIGN BODY

Three foreign bodies required removal. A gastrotomy was performed for removal of a staple which had remained in the stomach of a twenty-six month old girl for four days. A trichobezoar was removed from a six year old girl by gastrotomy. An open safety pin was removed from the jejunum of a three year old girl by jejunotomy.

OMPHALOCELE

Two infants were operated due to this condition. Both of them expired.

One child was a white male seventeen hours old. The sac contained only small bowel. During the removal of the sac, the bowel

was accidentally punctured. The skin was closed. He died of shock, peritonitis, hepatic deficiency with infarcts and lower nephron nephrosis.

The other child was a white female seven hours of age. The sac contained liver, spleen, large and small bowel. A first stage closure was done. Intake was poor and a jejjuno-abdominal fistula occurred; enterostomy for feeding purposes was performed. Death occurred eleven days later.

PRIMARY PERITONITIS

This disease entity occurred four times. The patients were nineteen days, three months, six years and eight years of age. History, physical examination and a flat plate formed the diagnosis in three cases. The average white blood count was 22,500.

A focus of infection was noted in two instances. Otitis media and pneumonitis were the sources.

The diagnosis was obtained after laparotomy for appendicitis in the fourth case. A sticky exudate simulating pneumococcic peritonitis was found. The abdomen was not drained. A culture of peritoneal fluid was negative.

All four patients improved on medical management.

SUMMARY

A brief analysis of clinical findings is presented, and case reports of eight patients suffering biliary tree obstruction are given.

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