5-1-1939

Appendicitis in children

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APPENDICITIS IN CHILDREN

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SENIOR THESIS

PRESENTED TO THE COLLEGE OF MEDICINE
UNIVERSITY OF NEBRASKA
OMAHA 1939
APPENDICITIS IN CHILDREN

Appendicitis in children usually produces a definite sequence of symptoms and findings. These are pain, nausea and vomiting, tenderness, and slight fever. These symptoms and findings may vary according to a number of factors concerned with the individual case. The factors include the anatomical development and physical condition of the child, the etiological factors, and the pathological processes involved.

Appendicitis develops more rapidly in children than in adults for three main reasons: first, because the appendix has a more delicate wall; second, because the omentum is poorly developed and delicate, so that it is incapable of walling off an inflammatory process as adequately as it does in the adult; and third, because the child has less natural capacity to resist intra-abdominal infection. (20), (37), (47), (58)

The disease is often more severe in children because of the tendency toward dehydration, since the body of the child contains relatively much more water than does that of the adult, and because the fluid balance of the child receives little attention prior to the time the patient is seen by the physician.

The appendix of the child varies considerably from that of the adult. It is relatively larger, longer, more funnel shaped and drains easily. (47) This feature may account for the relative infrequency of the disease in very young children. The position of
the appendix is less constant in a child. The cecum is more mobile, may be relatively higher or may not have undergone any rotation in the embryonic development of the gut. Cases have been described in which the tip of the appendix has been found adherent to the spleen and to the left kidney, and others in which the appendix has been found up under the liver, offering clinical confusion with hepatic disease. (39)

In some cases it is difficult to demonstrate any appendix, but a careful search may reveal that it is retroperitoneally placed.

If the cecum is located in the right lower quadrant, the appendix itself may occupy any one of nine positions. These are, in order of their frequency: first, into the pelvis; second, along the iliac vessels; third, to the promontory of the sacrum; fourth, posterior to the cecum; fifth, under the ileum; sixth, lateral to the cecum; seventh, into the iliac fossa; eighth, among the coils of the small intestine, and ninth, mesial to the cecum. (37)

Other points of interest relative to the structure of the appendix are its general shape and its histological structure. Since it is a blind pouch originating from the cecum, (a reservoir of bacteria), it is very easily infected. As regards its structure, it has three coats. The outer or serous coat is composed mostly of muscle, both longitudinal and circular,
which invests the whole organ except for one or two points. The submucous coat contains large masses of lymphoid tissue, which is believed by some (26) to be one reason why the appendix is often diseased. The mucous membrane is similar to that of the large intestine, but the intestinal glands are fewer in number. (25)

From a review of the anatomical considerations, it can be seen why some cases of appendicitis produce some difficulty in diagnosis.

While the exact etiology of appendicitis is unknown, there are a number of factors which must be given some consideration.

Appendicitis may occur at any age, although it is most commonly found in young adults. It is found in the aged and in very young children, the youngest case reported having occurred in a three day old infant. (37) Studies by many authors show that the incidence of the disease increases as the age increases. In support of a reason for this finding, Dr. Wyatt suggests that the toxicity of the intestinal flora increases with the increasing age of the child. (60) Dr. Gray, after reviewing a large number of cases, states that the amount of lymphoid tissue in the appendix increases as the child grows older, and he feels that lymphoid hyperplasia is an important etiolog-
ical factor. (26)

It is usually conceded that the disease occurs more often in males than in females, but in our study of 137 cases here in the University, more female than male children were found to have the disease.

Studies by Dr. Stone (54) and Dr. Angel (4), show that appendicitis is for the most part a summer disease. Dr. Angel in a study of 104 cases, lists the incidence as follows:

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Constipation may be considered as one of the most important of the predisposing factors. Dr. Dean Lewis states that the disease occurs much more frequently among the meat eating European Turks than among the Asiatic Turks, who subsist on a more bulky diet. He has also found that appendicitis is more common among persons leading a sedentary life, and relatively uncommon among persons leading a more active life. Dr. Lewis further states that the disease is almost unknown in Orientals, who assume a squatting position during the act of defecation, with the thighs acutely flexed on the abdomen, and that appendicitis rarely occurs in primitive peoples, as opposed to its frequency in occurrence among civilized peoples. (37) These findings
are consistent with the statements that constipation is more common among meat eaters, among those living a sedentary life, and among the more civilized peoples whose false modesty prevents them from responding to the desire to evacuate the bowel.

Familial susceptibility to appendicitis has long been considered a predisposing factor in the etiology of this disease, but it seems more likely that appendicitis occurs among several members of a family because of the habits peculiar to that family rather than because of an inherent predisposition to the disease. (37)

Diet has been touched upon above, but in addition to the prevalence of the disease among peoples subsisting on a diet which is more apt to produce constipation, Dr. Heyl suggests that the modern diet of the infant may cause an increase of the pathogenic bacteria in the colon, and subsequently may account in some cases for the occurrence of the disease in infants. (29)

Abnormal anatomical conditions of the appendix and other abdominal structures may predispose to the development of appendicitis. Among these may be listed congenital bands, angulations and twists. Dr. Gentile reports a rare case in which he found a partial prolapse of cecum; terminal ileum and appendix through a preformed opening in the omentum. (23)

Dr. Martin (39) lists four general determinate causes of appendicitis, namely: infection of the mucous membrane by pathogenic bacteria; mechanical interference with the blood
supply; obstruction by foreign bodies or intestinal parasites, and by congenital malformations.

Dr. Ascheff believes that the actual site of the beginning of the inflammatory process is in the pits and depressions of the mucous membrane where mechanical factors are conducive to the growth and penetration of bacteria. (37)

The bacteriology of appendicitis is not a clear cut entity. Dr. Haim (37) is of the opinion that streptococci are the most frequent infecting agents. He obtained streptococci in pure culture from 16 of 23 cases. The colon bacillus may be a secondary invader, but is probably not the usual primary invader. Dr. Bower (11) in his studies of blood from patients with appendicitis has demonstrated antitoxin for the Welch bacillus in the blood of 22.2% of unperforated cases, and in 46.6% of perforated cases. He concludes that the Welch bacillus plays an important part in spreading peritenditis of appendical origin.

The tubercle bacillus has been listed as a causitive organism by Dr. Thieme, who reported seven cases of primary tuberculous appendicitis. He found the clinical picture to be exactly like that of appendicitis due to other causes, and found the prognosis to be good. He also reported six cases of tuberculous appendicitis in patients having advanced pulmonary tuberculosis, five of which died postoperatively. He shows that
the prognosis of appendicitis in tuberculous patients depends upon the extent of the pulmonary lesions. (55) Some authors feel that appendicitis may be hematogenous in origin, but Dr. Aschoff's findings seem to contradict this opinion. Dr. Gray's theory of lymphoid hyperplasia tends to bring the hematogenous and enterogenous theories closer to one another.

Among the conditions producing mechanical interference with the blood supply may be listed intussusception, strangulated hernias, and mesenteric thrombosis. These conditions are considered further in the differential diagnosis, but it may be said that appendicitis may occur in conjunction with them, and that it may also occur following spontaneous reduction of intussusception and hernias which may have left the appendix with an impaired blood supply.

The obstructions undoubtedly play the major role in the etiology of appendicitis as precipitating factors. These may be divided into three general groups, namely: the foreign bodies and hyperplasias, the strictures and angulations, and the functional obstructions.

In the light of the knowledge that the appendix secretes fluid, Dr. Wangansteen and his colleagues state that its behavior under conditions of obstruction becomes understandable. It may be concluded that whether or not an appendix will rupture depends upon the acuteness and completeness of the obstruction, and Dr. Wangansteen states that "with gradual development of obstruction
or obliteration, undoubtedly complete luminal obstruction may be tolerated without rupture". (57)

In considering the foreign bodies, fecal concretions may be said to have considerable importance. These originate from bits of fecal matter having entered the appendix from the cecum, and consist mainly of fecal material and mucus. Some of these are very hard, while others may be relatively soft. These are capable of causing a pressure necrosis of the wall of the appendix, and producing a site favorable for perforation when the pressure within the organ increases sufficiently. (37)

Oxyuris may cause obstructive conditions in the appendix. Dr. Battaglia found this parasite present in 2% of cases, and more frequently in children than in adults. (6) Our study of cases in the University revealed two cases in which pinworms were demonstrated in the appendix postoperatively. The symptoms of parasitic infestation were absent.

Nut shells and other ingested foreign bodies have been listed as causes of obstruction of the lumen of the appendix. Mucocele of the appendix has been described as an infrequent cause of the disease, producing obstruction of the lumen. Prognosis in these cases is good except in those rare cases where the mucocele has undergone malignant change. (33)

One of the very important obstructive mechanisms is discussed by Dr. Gray. (26) Routine microscopic examination
of appendices postoperatively showed an increase in the amount of lymphoid tissue present. He offers the theory that acute infections are associated with a generalized lymphoid hyperplasia, and that the lymphoid follicles in the appendix do not escape involvement. He observed that this hyperplasia was most marked in young persons, especially adolescents and young adults, although there was relatively more lymphoid tissue present in children than in the middle aged and older age groups. He found that the involvement of the lymphoid follicles of the appendix resulted in deepening the crypts of the glands of the appendical mucosa, and even in blocking the lumen of the appendix in many cases. Such a theory is consistent with the finding that a great number of cases give a history of a preceding respiratory infection, and it is not contradictory to Dr. Aschoff's belief relative to the origin of the inflammatory process.

The strictures and angulations that lead to obstruction of the lumen of the appendix may be inflammatory or congenital in origin. These deformities may result from the development of scar tissue following an attack of appendicitis. The contractile action of a scar may twist the appendix until it is acutely angulated, or may even cause a blocking of the lumen of the organ. The possibility of congenital bands, angulations and twists has been previously mentioned.

Dr. Connell feels that functional derangement plays a
part in the production of obstruction of the lumen of the appendix. He states that "the ileocelecal region differs from all other gastro-intestinal situations in that the parasympathetic distribution is double, which permits the possibility of over-innervation or underinnervation. Sympathetic-parasympathetic imbalance is a possible cause of hypertonicity or hypotonicity at the ceco-appendical juncture. The existence of a true sphincter (Gerlach's valve) at this point has been denied, but circular muscle and extrinsic and intrinsic nerve supply, the necessary ingredients, are present. It would seem entirely justifiable to assume that disturbance in autonomic nervous balance might cause spasm or hypertonicity of the neuromusculature at the appendiceal juncture, which might help to answer the original question as to the why of the obstruction that caused a certain proportion of cases of appendicitis. It would seem probable that overparasympathetic or underparasympathetic innervation of the ileocelecal region is due to variations in embryologic development". (15)

The prevalence of appendicitis following an acute respira-

tory infection has been mentioned by a number of authors. (7),(35),(47),(60) Our own studies reveal that about 50% of the children admitted to the University with a diagnosis of acute appendicitis had a history of a recent upper respiratory infection. From a consideration of the etiological factors
presented above, it seems not unlikely that upper respiratory infections may be precipitating factors in producing a lymphoid hyperplasia, which may itself produce an obstruction, and which certainly would produce an obstruction more easily in an appendix the lumen of which is already partially obstructed by scars, angulations or congenital bands.

Another factor has recently received considerable attention from a number of writers. Trauma is considered by some to be a definite primary cause of appendicitis, while others feel that although it may speed up a pathological process already present, it is not to be considered as a primary factor. A study of a number of case reports, including one in our own series, seems to indicate that trauma, while an infrequent cause, must nevertheless be considered one of the primary causes. Most of the authors reporting cases are of the opinion that appendicitis occurs when some traumatic condition causes a sudden change in the pressure within the cecum, resulting in forcing fecal material into the appendix with such force that changes within the mucosa occur, and an attack of appendicitis results. Some feel that the force with which fecal material has entered the appendix has been sufficient to cause immediate rupture of the organ. In several of the cases cited, perforation occurred in less than 48 hours, so it seems that trauma must also be considered as a factor in early perforation. (13),(22),
Dr. Dean Lewis (37) lists six different pathological changes in the appendix, namely: simple catarrhal inflammation of the mucous membrane; diffuse infection involving the entire organ; gangrene, either localized or complete; abscess formation; ulceration or perforation. These various conditions may pass from one to another or may coexist in the same appendix at the same time. The peritoneal reactions may vary also. The exudate may be fibrinous, matting together the adjacent structures, and perhaps plastering the omentum about the inflamed appendix. On the other hand the peritoneal reaction may consist in an outpouring of fluid.

Dr. Wright (58) includes in the classification of pathological types an acute hypertoxic type, characterized by hypertoxic symptoms, and which is rapidly fatal unless operated early.

It must be remembered that during an attack of appendicitis, the appendix is not involved alone, but the mesentery of the organ is also involved. Dr. Beluffi (9) after microscopic study of 245 appendices and their mesenteries concludes that the appendicular mesentery shows microscopic lesions which vary with the form of appendicitis and are proportional to the severity of the disease. In acute appendicitis, the mesentery shows
edema, exudation, cellular infiltration, lymphangitis, rapid mobilization of reticulo-endothelial cells and perivascular infiltration. In grave cases, alterations of the local circulation take place and may be complicated by venous thrombosis and, in rare cases, by suppurative thrombophlebitis or liver abscess. After regression of acute appendicitis, the appendicular mesentery shows structural changes which are permanent and assist in a retrospective diagnosis of appendicitis. These changes may induce structural and functional disorders of the appendix which may be responsible for further attacks.

The danger of recurrent attacks in an appendix having once been diseased cannot be too greatly emphasized. It has been shown how angulations and twists, partial obstructions, may result from preceding inflammation. Dr. Wunder (59) lists a case in which diverticulae were found in an appendix that had been subject to many attacks. She feels that the numerous attacks were certainly contributory to the condition. Such an appendix, if suddenly occluded, would surely be more prone to rupture than would a previously normal appendix. It may be concluded then, that an appendix which has once been diseased is thereafter a potential menace to the health and perhaps to the life of the patient.

The case history of acute appendicitis usually follows
a definite sequence of events. The patient first complains of vague, intermittent, colicky pains in the epigastrium or generalized over the abdomen which become progressively more severe. Shortly after the onset of pain the patient becomes nauseated and may vomit. Usually vomiting occurs only once or twice at this time. Later, the colicky pains which have become progressively more severe gradually subside, only to recur again, and with this occurrence, the pain will have changed both in character and location. At this time, the pain is of a sharp, stabbing, continuous nature, and is definitely localized to one region of the abdomen. This region is usually the right lower quadrant of the abdomen, but its location is dependent upon the location of the appendix, which, as has been mentioned previously, may be found in any one of a number of locations.

Pain is the first symptom of which the patient complains, and is probably the most important symptom concerned with this disease. The pain of appendicitis is of two distinct types and has two distinct origins, and it is of importance to understand the nature of these two types because the one signifies an obstruction of the appendical lumen producing mechanical interference with normal peristalsis, while the other denotes actual inflammation of the appendix and adjacent structures. (5)

The first type of pain of which the patient complains is believed to be due to mechanical interference with the normal peristaltic activity of the appendix in its attempt to evacuate
its contents. At first there is only a relative increase in peristaltic motion which is probably reflex and myogenic in origin, and which may be responsible for restlessness, sleeplessness, changes in appetite, and abnormal intestinal habits. Dr. Nixon (43) states that a complete history shows the presence of some of these symptoms before the onset of definite pain. As the mechanical interference persists, the peristaltic movements become more violent, and the vague symptoms become more severe. The spasmodic, colicky, epigastric pain then appears. This pain is believed to be a reflex pain associated with the tenth, eleventh and twelfth thoracic nerves through the solar plexus. This pain becomes progressively more severe until tension on the visceral nerve endings in the wall of the appendix becomes so severe that the nerves are unable to carry further impulses, or until the tension is relieved, either by successful evacuation of the appendical contents, or by perforation. (43),(18)

As the tension within the appendix increases, the invasion of the appendical wall by the infectious process progresses until the entire wall of the appendix is involved. When this occurs and the diseased appendix comes in contact with the parietal peritoneum, an irritation of the somatic nerve endings in the parietal peritoneum is set up, and pain becomes localized in the region where this occurs, which depends
upon the location of the appendix. This pain may be superimposed upon the colicky type of pain previously discussed, but the patient usually describes the pain as having moved from the epigastrium to the central abdomen, perhaps to the left side, and finally to the right lower quadrant where it remains and becomes progressively more severe. This pain is sharp, stabbing, and continuous in nature, and is aggravated by motion, so that the patient prefers to remain quiet, where in the preceding type of pain, he was more apt to be restless.

It must be remembered that the description of pain presented above is that which is found in the classical case of appendicitis, and that there are many variations of this. These variations are mainly dependent upon the location of the appendix. Dr. Hardy (27) states that if the appendix lies retrocecaIly, the pain may be located in the flank and may be reflected down the posterior surface of the thigh, or up under the liver. If the appendix lies in the pelvis, the colicky type of pain may persist until perforation occurs, without the development of the typical localized pain. The position of the appendix in relation to other organs may complicate the picture. If it lies in contact with the ureter or bladder, dysuria may be produced, while if it lies in contact with the rectum, painful defecation may result. If the cecum has not rotated and the appendix lies high under the liver, pain may be localized
over the gall bladder region, and pain may be referred to the right shoulder, thus confusing the condition with cholecystitis.

Nausea and vomiting usually follow the actual onset of the initial pain within an hour. As is the case with pain, nausea and vomiting of appendicitis is of dual origin. The initial attack of this symptom is due to a reflex irritation of the visceral nerves. It is usually transient in nature, and does not produce any relief from pain. (5),(18),(27)

Later in the course of the disease, when the inflammatory process has involved the entire wall of the appendix, or after perforation has occurred, vomiting will recur, and this time it is a manifestation of toxemia. Vomiting may be due to bowel obstruction in those cases which have progressed to the stage of diffuse peritonitis. Dr. Hardy states that in some cases nausea or vomiting may not occur, but the patient will give a history of a profound distaste for food, and Dr. Lewis feels that a disinclination to eat is a more reliable symptom than nausea and vomiting. (27),(37)

Localized tenderness over the site of the appendix occurs when the inflammatory process has involved the entire wall of the appendix and the parietal peritoneum is irritated. The position of this tenderness depends upon the location of the appendix and upon its relation to the parietal peritoneum. When the appendix lies in actual contact with the peritoneum
of the anterior body wall, tenderness is very marked, and muscle
guard may appear early. If the appendix is retro-cecal, tender-
ness will be higher in the flank, and pain will be elicited upon
any motion of the right extremity which puts the psoas muscle
on a stretch. If the appendix lies in the pelvis, tenderness
will be low in the abdomen, and of a more general than localized
character. However, on rectal examination, tenderness may be
found to be very marked. For this reason, a rectal examination
should never be neglected in any case in which appendicitis is
suspected. (37)

Muscle guard and rigidity may occur in the adult before
perforation occurs, and is a valuable sign in diagnosis of appen-
dicitis in adults. Rigidity also develops in children, but
when it does one may feel reasonably certain that the process is
no longer confined to the appendix alone, but that complications
are developing. (53)

Fever is a variable sign in appendicitis. Early in
the disease there is usually no elevation in the temperature,
but later the temperature will show a slight elevation. Usually
it will range between 99 and 100 degrees. It may be normal,
and it may be 101 degrees or higher. Appendicitis does not
begin with a high fever, but it must be remembered that this
disease may develop during the course or following some other
infectious process which may be characterized by a high fever.
Dr. Hardy states that while it is usually believed that the height of the fever varies with the severity of the pathological process, there are many cases in which the temperature cannot be used at all as an index to the severity of the condition. Debilitated patients may run a subnormal temperature through the entire course of appendicitis and its complications. (27),(37)

The white blood count is of importance in making a diagnosis of acute appendicitis. In the classical case, the white count is elevated. In our series of cases in the University, the average white count in proven cases of acute appendicitis without perforation was 15,000, with an average of 75% polymorphonuclears. In the perforated cases, the average white count was 19,800 with an average of 81% polymorphonuclears. Dr. Mills (42) feels that the differential count is of greater value than the white count. He believes that the ratio of nonfilamented to filamented cells is particularly useful. When the ratio is less than one, that is, when there are more polysegs than staff forms, the prognosis is good, while if the ratio is nine to one in favor of the staff forms, the prognosis is very grave. He states that the reappearance of eosinophiles and monocytes and a disappearance of excess polymorphonuclears is a good sign. Dr. McLanahan (41) adds that the presence of a leukopenia in a case of acute appendicitis indicates an ominous prognosis.

Chills occur occasionally at the onset of an attack.
of acute appendicitis, but are usually considered as indicative of a rapidly developing gangrene of the appendix. Chills developing on the second or third day of the attack, and associated with a high fever are indicative of metastatic or embolic abscesses, particularly of the liver, since they are believed to be due to a septic thrombosis of the appendical veins which drain into the portal circulation.

Some authors feel that irregularities of bowel habits are nearly always present. Dr. Hardy states that constipation is usually the rule, and that at first it is reflex in nature, but later is due to inflammatory end results. Diarrhea may occur in children and in cases where an inflamed appendix lies in contact with the rectum. (27) It must be remembered that the tendency in the home to administer a cathartic in all cases of abdominal distress may be responsible for many cases of diarrhea associated with appendicitis.

The diagnosis of acute appendicitis may be easy or it may present a very difficult problem. The ease with which the diagnosis can be made depends upon the history presented and the accuracy of the history, the ability of the patient to describe his symptoms, the ease with which the patient may be examined, the physical findings elicited, and the laboratory findings.

Diagnosis is particularly difficult in the very young
child. If he is old enough to talk, he is usually unable to

give an accurate history, and the history obtained from the mother

called her attention to the child's illness. For this reason,

vomiting is often listed by the mother as the first symptom

presented. Another difficulty encountered in children is the

child's tendency to continue playing, in spite of the early

mild colicky attacks of epigastric pain, and stopping only

when the pain becomes severe. (53)

Appendicitis rarely occurs in the infant, fortunately, since in these cases the diagnosis is often most difficult. The child is not able to tell about his pain, but careful questioning of the mother may reveal that the child was awakened at intervals and cried as if in severe pain. It is difficult to examine an infant, and it is difficult to obtain any cooperation at all in palpation of the abdomen. The examiner's hand and heart should both be warm, but even so it may be necessary to anaesthetize the child before the examination may be completed.

The physical findings in acute appendicitis may vary with the individual case. The appearance of the patient depends largely on the extent of the pathological process, and may vary from a picture of mild discomfort to that of acute illness. In general it may be stated that the patient almost always assumes an attitude of flexion. If lying on his back, the patient will
usually have his knees drawn up, while if he lies on his right side, which is the position usually preferred, the spine and thighs will be flexed. He does not wish to be disturbed, but lies quietly in bed. The face is usually pale, and the skin is moist, as in all acute surgical diseases of the abdomen. The abdominal movement upon respiration is in reverse proportion to the acuteness and extent of the infection, and is influenced by the location of the appendix. Respiration is mainly costal in nature, but when it is abdominal, there is usually apparent retraction of the abdomen over the diseased organ with each inspiration. (27)

Dr. Hardy states that if the child can sit up without making the abdominal pain worse, or if the child voluntarily assumes a sitting posture, it is good evidence against the presence of acute appendicitis. He lists the tendency of the child to push away the examiner's hand when an attempt is made to palpate the abdomen, as evidence in favor of a diagnosis of appendicitis, but it is felt that this sign is not so reliable because often children resent being examined, whether there is any pathological process present or not. (27)

On auscultation, normal peristaltic sounds may be heard if the appendix is not ruptured and there is no local peritonitis, although the sounds may be minimized by a reflex ileus. After perforation occurs and peritonitis develops, the peristaltic
sounds will be absent. (27)

Percussion is often of value in locating an abscess. The cecum is usually tympanitic and may be used as a landmark. In some cases, the abscess occupies such a position that it is possible to outline it by percussion. (27)

The findings elicited by palpation vary with the location of the appendix. Tenderness is the earliest and one of the most important of the physical findings. It must be differentiated from hyperesthesia, which may be present in appendicitis and which is described as a cutaneous hyperesthesia corresponding to the distribution of the tenth, eleventh, and twelfth thoracic nerves, and which is bounded by a line drawn from the navel to the highest point of the right ilium, thence to the spine of the pubis, and thence to the navel. However, it has been pointed out to us by Dr. McLaughlin and Dr. Weinberg of the University staff that this sign is also present in pneumonia and occasionally in renal conditions. The differential point is that tenderness associated with an inflamed viscus is deep, and increases directly with the increase in pressure of the examining hand, while hyperesthesia is very superficial, and while it may be very marked, it becomes no more severe with deep pressure.

Dr. Hardy suggests palpation with the patient in the prone position when the presence of tenderness is questionable with the patient on his back. In case the appendix is retro-
cecum, tenderness will be most marked in the flank, but is seldom as high as the costovertebral angle. In pelvic positions, the tenderness may be very low in the abdomen, and may not be localized well. In these cases, a rectal examination will reveal very marked tenderness. The rectal examination is of great value in the child because the examining finger can reach relatively higher than in the adult. (37)

A number of signs have been described which, if present, assist either in ruling out or making a diagnosis of appendicitis. The skin sign and its relative value have been discussed above. The signs concerned with changes or pressure within the cecum by abdominal palpation are: Aaron's sign, in which pressure over McBurney's point produces pain in the epigastric, umbilical or left hypochondriac regions; Rovsing's sign, in which pressure along the colon in the direction of the cecum produces pain at the site of the location of the appendix; and Owen's sign of rebound tenderness elicited by sudden removal of the palpating hand after gas has been driven out of the cecum by steady pressure of the palpating hand. This sign is similar to Blumberg's sign of rebound tenderness following pressure anywhere in the abdomen, which he feels is indicative of active peritonitis. He states that after the inflammation subsides, the pain produced by pressure is greater than the rebound tenderness. (27),(31)

Another group of signs are concerned with the ruling
out of chest pathology by pressure on the phrenic nerves. Lliescu produced pressure on each side of the neck in the centers of the triangles formed by the origins of the sternocleidomastoid muscles, causing compression of the phrenic nerves. If the sign is positive, a quick subsidence of the abdominal symptoms occurs, and the lesion is said to be above the diaphragm. Salzer modifies this test by producing pressure on the phrenic nerves where they pass over the scalenus anticus muscles, and if there is any marked difference in sensitivity on the two sides and the patient makes a movement of defence, the lesion is said to be above the diaphragm. (27)

Other signs are concerned with pressure on blood vessels, and with muscular movements producing pain. The femoral sign is elicited by compressing the right femoral artery as it passes below Poupart's Ligament. This increases the pressure in the iliac artery, and, in the presence of a diseased viscus, produces pain. The obturator sign is positive when there is pain on inward rotation of the thigh, and is indicative of a pelvic appendicitis. The psoas sign consists of the production of pain when the patient is placed on his left side and the right thigh is hyperextended. Meltzer's sign is a modification of the same principle and consists of having the patient lie on his back, while the examiner gradually elevates the extended right leg, which is kept rigid. If the appendix lies in contact
with the psoas muscle, these signs will be strongly positive, and they will be positive also if the diseased appendix is compressed between the psoas muscle and the abdominal wall. (27),(31)

Richet and Netter believe that contraction of the adductors of the thigh is an important diagnostic sign. With the patient lying on his back, thighs half flexed, heels flat on the bed, and knees touching, the knees are separated by mild, constant, equal pressure. The adductors of the right leg may contract slightly or markedly. The sign can never be elicited by force. It is equally effective with children and adults. The authors found it positive in about 40% of cases of acute appendicitis, and never present in other disorders of the right side of the abdomen. (48)

The laboratory aids to diagnosis should consist of a complete blood count and a urinalysis. A sedimentation rate is desirable. The white count and differential have been discussed previously. A urinalysis is of value mainly in ruling out renal conditions, although it must be remembered that some pus cells may be present if the appendix lies in contact with the ureter or bladder. Dr. Hardy feels that the sedimentation rate is of definite value. He quotes Dr. Lesser as stating that in a study of 2,000 cases the sedimentation rate of acute appendicitis was uniformly normal, except in cases which were associated with
peritonitis, while in all other abdominal conditions simulating appendicitis, the sedimentation rate was abnormal. (27) However, Dr. Fry and Dr. Lintgen found the sedimentation rate abnormal in 52% of their cases of acute appendicitis, but they noted that it was not as rapid as in acute pelvic inflammatory disease. They concluded that the test was not reliable in itself, but had some value if correlated with other findings. (38)

When there is a question as to the differential diagnosis, examination of the stool for occult blood may be of value. A history of bright blood passed at one time and dark blood passed at another time is suggestive of an inflammation of a Meckel's diverticulum. (12)

Acute appendicitis may be confused with a number of conditions. Probably the conditions simulating this disease which are most often encountered in the child are colic, acute and chronic gastro-enteritis and constipation.

Colic occurs in infants and is characterized by paroxysmal attacks of abdominal pain, each of which runs an agonizing course and departs suddenly. These attacks may occur daily. The pain is somewhat relieved by pressure over the abdomen, and is completely relieved by the expulsion of flatus. There is no fever associated with colic. (40), (60)

Acute gastro-enteritis usually results from some dietary
indescretion, and may be characterized by nausea and vomiting, diarrhea, moderate fever, although the fever may be high, abdominal distention, increased pulse rate, coated tongue, and fetid breath. Vomiting produces some relief. The rectal examination is negative, and the white blood count is usually not elevated. Chronic indigestion is associated with diarrhea, and abdominal distress which is almost constant, and which may cause the patient to cry a lot. (5),(12),(27)

Constipation may be confused with appendicitis, in that it produces abdominal discomfort, and general malaise. History of the bowel habits and dietary habits is valuable in making the diagnosis. Colic may be based on a constipated condition. (60)

The upper respiratory infections, including pneumonia, pleurisy, pharyngitis, tonsillitis, otitis media, and the exanthemata may be confused with acute appendicitis. Meningitis may also be considered in this group. In our study of 137 cases entering the University Hospital with a diagnosis of acute appendicitis, 9 were found to be suffering with upper respiratory infections and were sent home, and another with typical symptoms of acute appendicitis, was operated and the appendix was found to be negative. This patient was later diagnosed as lobar pneumonia.

Of these diseases, pneumonia is probably the most
important because of the gravity of the disease and because it may produce symptoms that are very similar to those of acute appendicitis. Pneumonia is most apt to simulate appendicitis when it occurs in the base of the right lung, and is associated with a peripheral diaphragmatic pleurisy. Dr. Edwards (20) states that when there is a question as to whether an inflammatory lesion is in the abdomen or the chest, it is usually in the chest. A review of the symptoms and findings in cases of pneumonia may tend to bring out points of difference between the symptoms of that disease and appendicitis, even though there may be some similarity between the symptoms.

The immediate previous history may or may not be of value, because both conditions may be preceded by upper respiratory infections. The appearance of the patient in the two conditions is different and is of great value in differentiation. In pneumonia, the patient is restless, his face is flushed, his skin is dry, and he appears to be quite ill. He may have some respiratory embarrassment. Respiration is shallow, rapid, mainly abdominal, with definite splinting over the involved lobe, his ali nasi may be at work, and he may have less respiratory embarrassment if his head is somewhat elevated. The patient with appendicitis assumes an attitude of flexion. He may not appear to be very ill. His face is pale and his skin is moist. His respiratory motions are mainly costal, and the abdomen is splinted
over the region of the appendix. He prefers to lie quietly, and may complain if he is moved or touched. The fever is usually different in the two conditions. In pneumonia it occurs early and is high, usually ranging between 103 and 105 degrees. In appendicitis it is usually not high and occurs late in the disease. Nausea and vomiting are much more constant in appendicitis than in pneumonia, but may be present in both conditions. In pneumonia, the abdominal pain is usually generalized, severe and constant. In appendicitis, when the pain is general in character, it is colicky in nature, and when it becomes more constant it is usually well localized. Tenderness in pneumonia is superficial and may be very severe. It is usually diffuse and high in the abdomen. It is not made worse by deep abdominal pressure. In appendicitis, the tenderness is made worse by pressure, but may not be so severe superficially. The rectal examination is negative in pneumonia but usually will reveal some tenderness in appendicitis. The leukocyte count in pneumonia is usually between 20,000 and 50,000. In appendicitis, it runs between 10,000 and 20,000. Localized lung findings such as dullness, tubular breathing and rales may not be elicited early, although they appear later in the course of pneumonia. The presence of rusty sputum is of advantage in assisting in the diagnosis of pneumonia, although young children tend to swallow their sputum.

In spite of the markedly different pictures presented
by classical cases of these two conditions, the occasion does arise in the early stages of the two diseases when it is almost impossible to differentiate between them clinically. If there is any occasion when it is wise to wait when a diagnosis of appendicitis is considered, it is when there is a question as to whether or not one may be dealing with a case of pneumonia. It is here that the final diagnostic procedure is of the most value. The X-ray studies of the chest may be the only diagnostic procedure which will differentiate the two diseases. (20),(34)

The possibility of the simultaneous occurrence of both diseases must not be forgotten.

Diaphragmatic pleurisy may be confused with acute appendicitis, but symptoms referable to the chest are usually prominent, especially that of severe pain associated with inspiration. A friction rub may be heard with the stethoscope, and an X-ray of the chest may reveal the etiology of the pleurisy. (12),(47)

Two of the cases in our series, entered the hospital with a provisional diagnosis of acute appendicitis and were found to have common colds. Three cases were found to have tonsillitis, one had otitis media and two had upper respiratory infections which were not further classified. In differentiating these conditions from appendicitis, Dr. Wyatt states that in the upper respiratory infections the pain is always greater than the
abdominal tenderness, while the reverse relationship is the rule in acute appendicitis. Vomiting and fever may accompany the more severe upper respiratory infections, such as otitis media, but may precede the pain. A complete physical examination, with attention to the signs of appendicitis, may in many cases confirm a diagnosis which may not have been clearly suggested by the history. It is to be remembered that acute appendicitis frequently complicates throat infections. (60),(31)

Measles, scarlet fever and meningitis may be confused with appendicitis in their early stages. In these cases, nausea and vomiting usually precede the onset of pain. In the latter two, fever is usually very high and there are other signs which are of differential importance, such as the typical throat, circumoral pallor and flushed face of scarlet fever, and the headache, retracted head and rigid neck of meningitis. Measles may be differentiated by the demonstration of Képlik's spots before the rash develops and by the leukopenia which is one of the characteristics of the disease. Appendicitis may occur in conjunction with these diseases and it may be particularly severe when it occurs as a complication of measles. (12),(31),(60)

Diseases of the urinary tract may simulate acute appendicitis. Of these, the most common is pyelitis. This condition is more commonly found in girls, but is not rare in boys. Acute pyelitis usually begins with a chill and a high
fever. The patient may complain of frequency in urination, and a urinalysis will reveal the presence of pus cells in clumps. The fever in pyelitis runs a saw tooth course. In acute appendicitis, fever is a late symptom and is not high. When chills occur with the onset of appendicitis, one thinks of an early gangrene, so the presence of chills demands a rapid diagnosis. If the appendix lies in contact with the ureter, a few pus cells may appear in the urine, but not in such great numbers nor in clumps, as they do in pyelitis. Because of the frequency of the occurrence of pyelitis, a urinalysis should not be neglected in cases which are believed to be appendicitis. (12),(39)

Ureteral calculus presents a picture which in classical cases is very different from appendicitis, but in some cases may appear to be similar. The patient is very restless and the pain is paroxysmal in nature and very severe. Nausea and vomiting may occur reflexly. Usually there is no fever. Tenderness is present over the right costo-vertebral angle. Diagnosis is made from the history of the present attack, from the finding of hematuria and pyuria, from cystoscopic examination with ureteral catheterization and from roentgenological studies of the urinary tract. The routine urinalysis may pick up the clues which will indicate further studies of the urinary tract and lead to a correct diagnosis (in cases in which a diagnosis
of acute appendicitis has been considered). (27),(37),(39)

Perinephritic abscesses are usually characterized by an insidious onset and a septic temperature. The chief complaint is usually that of a dull ache in the flank. The major findings are marked tenderness in the costovertebral angle and a typical curvature of the spine, which may be either a scoliosis or a lordosis. This finding is of considerable value in differentiation when it is remembered that in acute appendicitis the attitude is usually that of flexion. (27)

Dietl's Crisis, or kinking of the ureter with the production of an acute hydronephrosis may occur, and is characterized by sudden, severe, lancinating pain in the side associated with tenderness in the costovertebral angle. The pain is often relieved by placing the patient in the Trendelenburg position. (27)

The intestinal obstructions usually produce rather acute symptoms and findings and when confusion with appendicitis occurs, it is usually when the appendix has ruptured and generalized peritonitis has developed, and when an accurate history is difficult to obtain.

The symptoms of acute intestinal obstruction vary in severity according to the cause of the obstruction but may be listed as pain, which may be localized or generalized; vomiting, which rapidly becomes fecal in character; shock, which varies with the cause of the obstruction; distention, which is usually
very marked; and in many cases, by the palpation of a tumor mass. In generalized peritonitis from a ruptured appendix, the patient appears to be dehydrated and presents the drawn, shrunken Hippocratic facies. Vomiting is regurgitant in nature, although it may be fecal in character. The abdomen is usually distended and boardlike rigidity may be presented. The fever is very high and the leukocyte count may be from 20,000 to 50,000 or higher.

Strangulated hernia, besides presenting the symptoms of vomiting and distension, is further characterized by a sudden onset and localized tenderness over the herniation. The hernia is usually easily palpated and the diagnosis is made. Occult hernias without obstruction may occur and may be confused with acute appendicitis. Often an appendectomy is performed and a normal appendix found, but an exploratory reveals a hernial sac in the inguinal canal. In these cases, the correct diagnosis may be suspected but actually not made prior to operation. This condition must be kept in mind. (1),(60),(Dr. H. H. Davis, Surgery Clinic Lecture 3-20-39)

Bands and adhesions most often occur postoperatively and so are not met frequently in children. In these cases, the obstruction may arise gradually but eventually the picture is that of acute intestinal obstruction.

Intussusception is listed by most authors in the
differential diagnosis of acute appendicitis. Intussusception is usually of the ilio-colic type in infants, but it may be colico-colic in older children. (1) This disease is characterized by screaming attacks of pain, which occur without warning, and which are followed by relief in a few minutes. These paroxysmal attacks occur every hour or two. Vomiting may occur. Stool examination reveals the presence of blood and mucus but no feces. Shock may be severe. Often a sausage shaped mass may be palpated in the abdomen. (20),(60)

Volvulus, when it occurs, usually involves the sigmoid colon or the cecum. It is characterized by a sudden onset of pain, vomiting and severe shock. Distension is marked and a tumor mass may be palpable. (27)

Mesenteric thrombosis rarely occurs in children. It is associated with the symptoms of acute intestinal obstruction. Shock may be marked. The history is of value in suggesting the origin of the embolus that produced the thrombosis. (39)

Foreign bodies may produce intestinal obstruction and the symptoms are similar to those of other types of obstruction, although the onset may not be as acute. The history of the case is of value in learning the nature of the object swallowed and the X-ray is a valuable aid in locating the position of the foreign body, both by outlining the foreign body if it is opaque and by indicating the level of obstruction. (31),(46)
Pyloric stenosis might be confused with acute appendicitis in the very young infant, but the former disease occurs at a time when acute appendicitis is very infrequent and presents a group of findings which are almost constant. Pyloric stenosis becomes evident at about the second week of life and is characterized by forceful vomiting following shortly after the ingestion of food, visible peristaltic waves progressing over the abdomen from left to right, palpable tumor mass about the size of an olive, failure to gain or weight loss, small stools and a small amount of concentrated urine. If the infant is not seen until late in the course of the condition, he will show evidence of starvation and dehydration. (40),(60)

Mesenteric lymphadenitis is often confused with acute appendicitis. Dr. Gatch, in Christopher's Textbook of Surgery, states that pain is one of the initial symptoms of this condition. This pain differs from that of acute appendicitis in that it begins in the right iliac fossa and remains there. Tenderness may be generalized over the abdomen but it may be more marked in the right lower quadrant because the glands near the lower ileum are most commonly involved. Fever occurs occasionally and ranges between normal and 100.6 degrees. Leukocytosis is moderate. Flatulence, dyspepsia and general malaise are listed as other clinical symptoms. In some cases, the lymphadenitis may be due to tuberculosis and in such cases
Dr. Martin (39) suggests that the X-ray and the Pirquet test may be of diagnostic value. The main differential points between mesenteric lymphadenitis and acute appendicitis are the presence of nausea and vomiting in appendicitis and the difference in the site of the initial pain in the two diseases. When there is doubt concerning the exact diagnosis, most writers feel that an occasional unnecessary operation is safer than the complications of a perforated appendix. (12),(34),(27)

Crohn's disease, regional ileitis, may be confused with both the acute and chronic forms of appendicitis. (45) It is a disease of the young and is usually encountered in the older children and in young adults. Dr. Jackson (32) divides the disease into four stages and it is in the first stage that the disease resembles acute appendicitis. The symptoms of regional ileitis are moderate diarrhea, abdominal cramps, right lower quadrant pain, slight leukocytosis and later, weakness, weight loss and moderate anemia. The condition may give rise to intestinal obstruction. (30) The findings in this disease are mucus, blood and pus in the stool, palpation of a tumor mass in the right lower quadrant in late cases and typical X-ray findings. (16),(30),(32) In many cases a diagnosis of acute appendicitis is made and an appendectomy performed. If the condition is not discovered at operation, the patient is not relieved of his symptoms and goes on to the late stages of the disease. Some authors feel that the presence
of an old appendectomy scar in the face of symptoms referable
to some lesion of the right lower quadrant offer a clue to the
possibility of the condition being an ileitis. (32) It has
been suggested by some writers that a routine examination of the
terminal ileum should be done in all appendectomies to rule out
the presence of regional ileitis. Dr. Lawen (36) states that
there is one type of regional ileitis in which the appendix is
involved, so it is to be remembered that acute appendicitis may
coexist with Crohn's disease.

The treatment for both acute appendicitis and regional
ileitis is surgical. Dr. Crohn feels that a radical resection
offers the best hope of a cure in regional ileitis. (16) Dr.
Oppenheimer and others have performed short circuiting operations
with fairly good results. (45)

Right sided or regional colitis may simulate appendicitis.
Dr. Crohn lists one case occurring in a boy eight years old. The
symptoms of this condition are similar to those of regional
ileitis, namely: moderate diarrhea, abdominal cramps associated
with and relieved by defecation, an afternoon fever of 101 to
104 degrees, rarely nausea and vomiting, slight leukocytosis,
and later, weight loss, weakness and moderate anemia. Stool
examination reveals the presence of blood, pus and mucus. The
X-ray is a valuable aid to diagnosis. The treatment consists
of radical resection of the involved bowel. (17)
Pelvic conditions in girls may offer some confusion with acute appendicitis. These conditions are rare in children, although they may present some of the major diagnostic problems in adult women. Salpingitis and an ovarian cyst twisted on its pedicle are the pelvic conditions which offer the most difficult diagnostic problems.

Acute salpingitis is characterized by a high fever, low bilateral abdominal pain, vaginal discharge and dysuria. The white count is usually very high and the sedimentation time is rapid. Examination will reveal bilateral tenderness and it will be low in the abdomen. On rectal examination, movement of the internal genitalia is very painful and bilateral tender masses may be palpated. (27),(39)

An ovarian cyst twisted on its pedicle is a rare condition in children but it is not to be forgotten. This condition is characterized by sudden pain often following mild trauma or unusual exercise, abdominal rigidity, distension, moderate shock, fever, leukocytosis, vomiting and dysuria. Rectal examination usually reveals a tense and extremely cystic mass. In considering the types of appendicitis which this condition might simulate, that associated with trauma would probably offer the most difficulty in diagnosis. The treatment in either case is immediate operation. (12)

Inflammation of Meckel's diverticulum may present
symptoms identical with those of acute appendicitis. This anomaly is believed to be present in from 2 to 4% of all infants and while it may never produce any difficulty, the possibility of its persistence must not be forgotten. Dr. Brennemann states that the stool examination is of importance in differential diagnosis. If the patient has passed bright blood at one time and dark blood at another, one should be strongly suspicious of the presence of this condition. (12) When an operation reveals a relatively innocent appearing appendix, an examination of the terminal four or five feet of the ileum may reveal an acutely inflamed Meckel's diverticulum. This condition is dangerous because the inflammatory process proceeds so rapidly. (1),(8),(27)

Tuberculosis of the spine and hip may offer some confusion with appendicitis, since in Pott's disease, psoas abscesses may develop and the nerve roots may be involved, giving rise to abdominal pain, while in tuberculosis of the hip, the typical deformity of flexion and adduction is the same as that produced by acute appendicitis and pain on motion of the extremity is a feature of both conditions. Diagnosis of the tuberculous conditions is made by the correlation of the history of contacts with the findings on complete physical examination and with the X-ray studies of the spine, hip, chest and abdomen. (12),(60)

Acute suppurative diseases of the hip may offer some confusion but are attended by high fever, chills and extreme
bone tenderness. A carefully taken history is of great importance. X-ray studies of the region may aid in diagnosis and aspiration of the joint capsule may confirm it. (39),(60)

Typhoid fever may occasionally be confused with appendicitis but is characterized by a gradual onset, fever, headache, leukopenia, rose spots and splenomegaly in the typical case. The gradual onset, the early appearance of fever and the leukopenia are the main differential points. Appendicitis can complicate typhoid fever and is to be differentiated from perforation of a typhoid ulcer. If appendicitis develops during the course of typhoid, it usually does so between the third and fifth days after the onset of the disease and its presence is indicated by the appearance of abdominal pain and tenderness, which becomes localized as in other cases of appendicitis. Perforation of a typhoid ulcer occurs during the third week of the disease and is attended with shock and rigidity of the abdomen. (12),(27)

Cholecystitis and cholelithiasis rarely occur in children. In our series of cases, one case entered the hospital with a diagnosis of acute appendicitis, was operated and a cholecystitis was found. This patient was not jaundiced and pain was not referred to the shoulder but was entirely abdominal. The symptoms and findings occurred in the sequence typical of acute appendicitis. Dr. Wyatt feels that a differential diagnosis is most difficult in such cases. It is possible that a
yellowish tint to the sclera might present the only clue to
the accurate diagnosis and would indicate a Van den Bergh test
and other studies referable to the icterus index and to liver
function. (60)

Pneumococcic peritonitis may simulate acute appendicitis
so closely that diagnosis in many cases cannot be made preopera-
tively. Dr. Bell (8) cites a case in which the symptoms and
findings were pain, nausea, fever ranging from 100.4 to 104
degrees and a white count of 14,300. In our series, there is
one case of pneumococcic peritonitis following pneumonia. The
symptoms presented by this case were pain which was not severe,
nausea and vomiting, generalized tenderness and right sided
rigidity, fever of 104.4 degrees and a white count of 43,400.
This patient entered the hospital with a diagnosis of broncho-
pneumonia and acute appendicitis. The abdomen was opened and
drained and the patient recovered.

The acidosis associated with diabetes may be confused
with appendicitis because of the vomiting, but should be easily
ruled out by the appearance of the patient and a few findings.
The patient who is in a state of acidosis, besides vomiting,
has a flushed face, dry skin, Kussmall type of breathing,
acetone odor to the breath and a urine examination will reveal
the presence of sugar. (12)

The possibility of lead poisoning should not be over-
looked, although it occurs infrequently. Children have a tendency to chew on furniture, toys and such things, which may have been painted with paint containing lead. The chief symptoms are abdominal pain, rather obstinate constipation, occasional vomiting and later in the disease, a marked secondary anemia. (40) Occasionally there may be associated symptoms of an encephalitis.

Other diseases which are rarely met and which may simulate acute appendicitis are angioneurotic edema and allergic conditions (46), pancreatitis, which is very rare in children and which is extremely difficult to differentiate from acute appendicitis preoperatively (39), pericarditis (29), pneumococcic endocarditis (8), rheumatic fever (29), and cysts of the cecum, mesenteric cysts, torsion of the omentum and purpuric colic (12).

To this point, the discussion has been concerned mainly with uncomplicated appendicitis and the disease process has been described up to the time at which perforation occurs. Unless the attack subsides, perforation will occur and this leads to the development of the complications which make appendicitis a dreaded disease. As soon as perforation occurs, there is some local peritonitis set up due to the local soiling and the patient begins to show evidence of this condition. The abdomen becomes more tender and rigidity may be marked over the site of the appendix. The temperature rises and now ranges between 101 and 103
degrees. Vomiting may recur. The leukocyte count is increased and is found to range from 16,000 to 25,000 and the percentage of polymorphonuclear and staff forms show about a ten per cent increase. The appearance of the patient has changed also. The face may be drawn and anxious. The tongue is coated and the mouth is dry. Chills may occur and if they persist, a thrombophlebitis of the appendical vein may be suspected. This may lead to a pylephlebitis and multiple liver abscesses which may cause the death of the patient. (18),(28),(37)

From this point, at which there is local soiling, the process may take one of two courses. It may go on to abscess formation or it may develop into a generalized peritonitis. If conditions are such that the omentum and ileum can effectively wall off the infectious process and if there has not been any catharsis so that the gut remains quiet, the tendency is toward abscess formation. The location of the abscess depends upon the location of the appendix. The most frequent site is between the cecum and the anterior abdominal wall. An abscess in this location may reach considerable size and cause a visible fullness in the right lower quadrant. If the tip of the appendix extends to the midline, an abscess may form on the left side of the abdomen, being directed there by the root of the mesentery. Pelvic abscesses may arise. These are usually detected by rectal examination and may produce symptoms of painful defecation and
dysuria. These may rupture spontaneously into the rectum or vagina. When abscess formation develops following perforation of a retrocecal appendix, it produces flank pain and tenderness but abdominal rigidity may be absent. Such abscesses may rupture spontaneously into the ascending colon, but are more apt to extend upward and form a subphrenic abscess. Perinephritic abscesses may develop. (14),(37)

A generalized peritonitis may develop if the patient has been given a cathartic and the gut thrashes about in the abdominal cavity, if the infection is due to some highly virulent organism so that perforation occurs rapidly and if the omentum and small bowel are ineffective in their attempt to localize the infection. This complication is characterized by diffuse abdominal pain and tenderness, rigidity, distension, absolute constipation, regurgitant vomiting which may be fecal in character, shallow, costal respiratory movements and the drawn, shrunken Hippocratic facies of generalized peritonitis. (18),(20),(37)

Chills beginning on the second or third day of the attack, point to the possibility of a thrombophlebitis of the appendical vein with a resultant pylephlebitis and multiple liver abscesses. Chills and fever usually persist throughout the remainder of the course of the disease. The liver becomes enlarged and jaundiced, or at least, a subicteric tint may be
seen. This condition may occur postoperatively. The prognosis is bad if liver abscesses develop. This complication is held responsible for from 3 to 5% of the deaths occurring from appendicitis. Dr. Hawkes advocates ligation of the ileocolic vein. Ligation of the smaller veins is more difficult technically, may produce nutritive disturbances in the intestinal wall and is less efficient in preventing extension of the thrombotic process. Dr. Braun feels that the ligation of the ileocolic vein is indicated in every case of acute and chronic appendicitis in which symptoms of septic thrombosis of the liver are present. (28),(37)

Pulmonary embolism occurs occasionally in acute appendicitis and is a result of thrombosis of the veins of Retzius or of those of the pelvis or lower extremities. Thrombi develop in those cases in which the infected appendix lies adjacent to the vein. Death may occur if a large clot breaks loose and if smaller emboli reach the lungs, pleural pain, bloody expectoration and a friction rub may develop. One of the cases in our series died of pulmonary embolism following an iliac thrombophlebitis. (37)

Among the late complications of appendicitis, post-inflammatory or postoperative adhesions are probably the most important. These may produce intestinal obstructions. Dr. Dean Lewis states that the occurrence of adhesions increases directly with the extent of the inflammatory process. (37)
Another late complication of appendicitis in the female is sterility. Von Mikulicz-Radecki in his studies found that 14% of the cases of sterility were due to appendicitis and that this disease ranked third in the production of sterility in the female. Further studies disclosed that after uncomplicated appendectomies the incidence of sterility was 12.7%. After complicated appendectomies, it was 20% and after drainage of pelvic abscesses through the pouch of Douglas, it was 27.3%. (56)

The prognosis of acute appendicitis depends upon how soon the patient calls a physician, whether or not the patient takes a cathartic, whether the physician recognizes the gravity of the situation and consults a surgeon and whether or not the surgeon gives the case his immediate attention. Delay and catharsis are the two major causes of the high mortality rate of acute appendicitis. (18)

The mortality rate of acute appendicitis is not decreasing, as would be expected, in the light of greater knowledge and perhaps better technical skill, but is increasing. (18) Dr. Fitz quoted by Dr. Aynsworth (5) states that in 1900 the mortality rate from acute appendicitis was 8.7 per 100,000 population, while in 1934 this figure had increased to 14.7 per 100,000 population. Dr. H. H. Davis, of our University staff, has told us that there are approximately 20,000 deaths from
appendicitis in the United States every year.

In defense of the statement that delay is one of the major causes of the mortality of acute appendicitis, it may be said that the interval between the onset of symptoms and the time of operation has considerable bearing on the prognosis of the case. Dr. H. H. Davis, in a study of 960 cases of acute appendicitis has found that if the patient is seen and operated within the first 12 hours after the onset of symptoms, the mortality rate is practically nil. In those cases operated between 12 and 24 hours after the onset of symptoms, the mortality rate is 2%. Those seen in the next 12 hour interval have a death rate of 4% and those seen between 36 and 48 hours have a mortality rate of 7%. These findings are almost identical with those listed by Dr. Maes and quoted by Dr. Dean Lewis (37), who found that the death rate in patients seen and treated within the first 24 hours of the disease was 2.7%, while in those patients in whom symptoms had persisted for more than 24 hours, the death rate was 6.5%. Dr. Pounders (47), in his series, found that there were no deaths in patients operated before the occurrence of perforation but including perforated cases, his mortality rate for the whole series was 8%. Dr. Schmidt (51) studied 615 cases of acute appendicitis in college students and compared the findings in these cases with the findings presented by a similar number of less well advised patients. Of the first
group, 75% entered the hospital within the first 24 hours of illness, none had taken any cathartic and only two had perforated. The mortality rate in this group was nil. In the second group, only 45% entered the hospital on the first day of illness, 20% of them had taken cathartics, 19% of them had perforated and the mortality rate was 5.68%. Dr. Flannery (21) found a death rate of 2% in his series of operated cases. Of those patients having gangrenous appendices and perforation, 20% died and 50% of the cases with spreading peritonitis died. In our own series of cases, with a mortality rate of 5.9%, the duration of symptoms in the fatal cases ranged between 24 hours and 7 days. In one case, the actual time of onset of acute appendicitis was unknown.

In a review of reports on several series of cases, it is found that patients dying of acute appendicitis actually die of the complications of acute appendicitis. Dr. Allen (3) found the death rate from abscess cases to be 2.59%. Causes of death in these patients were sepsis, multiple abscesses and general peritonitis, and liver abscesses. The cases having spreading peritonitis had a mortality rate of 17.4%. Death was due to profound toxemia, pneumonia, paralytic ileus and pulmonary embolism. Dr. Hawkes (28) states that from 3 to 5% of deaths from appendicitis are due to pylephlebitis. In our own series, two cases died of abscesses and associated sepsis. One of these
had a hemolytic streptococcus infection, the other a long sinus abscess and in both gangrenous appendices were found at the time of operation. Another case died of pelvic peritonitis and thrombophlebitis of the left iliac vein and the last died of a spreading peritonitis and bowel obstruction.

The age of the child is of prognostic significance. Dr. Allen (3) in his study of 612 cases of acute appendicitis in children, found a total mortality of 5.8%. In the children under five years of age, there occurred 11 deaths, or 15.2%, 9 of which were due to spreading peritonitis. Dr. Martin (39) quoting Dr. Farr, states that the death rate is 13% in the first four years of life. In their series of 1,459 cases, the total mortality rate was 6%.

The administration of cathartics to patients suffering from acute appendicitis is considered by many to be one of the major factors in the development of complications which are responsible for most of the deaths. Dr. Schmidt (51) found that the mortality rate was increased in those cases having received cathartics, and Dr. Allen (3) found that 50% of the perforated cases in his series had received such medication. In the unperforated cases in his series, 42% had received cathartics. No history referable to such medication was obtained in 32% of the charts. He concluded that cathartics undoubtedly hasten perforation. In our own series, 20.8% of the clean cases gave
a definite history of having taken laxatives, while such a history was obtained in 47.2% of the perforated cases. Dr. Wright (58) reminds us of the axiom, "No purgative, no perforation", and states that, while there are exceptions to this rule, the administration of cathartics does have a definite bearing on the prognosis of the case.

At the present time, we are taught that cathartics have definite indications in the practice of medicine, but that in cases in which the presence of acute appendicitis may possibly be considered, any form of laxative is contraindicated. In the past, before much was known about appendicitis, purgatives were prescribed by physicians for most symptom complexes indicative of gastro-intestinal disease. The lay public, having been given cathartics by physicians in the past, and having access to numerous laxative preparations, have often resorted to self medication in case of abdominal pain, believing that a "good cleaning out" will alleviate their symptoms. It is extremely difficult to dislodge such a belief because, in the first place, purgative medication has almost become traditional and in the second place, manufacturers of patent medicines containing cathartics have capitalized on this tradition and have taken advantage of modern methods of advertising which bring considerable attention to their products.

The harm done to the patient by the administration of
a cathartic which causes an irritation of the entire intestinal tract, setting it in motion and breaking down protective but perhaps delicate adhesions and enhancing a generalized spread of infection throughout the abdomen, is not difficult to understand. In addition, it may be stated that, besides the damage done to the patient, the results of the administration of the purgative may easily confuse the clinical picture and add to the already too great number of mistaken diagnoses.

Among the other factors contributing to the mortality rate of acute appendicitis, Dr. Heyl (29) suggests that perhaps the high death rate may be due in part to the fact that many inexperienced surgeons are operating these cases. He states that the mortality rate is decreasing in the larger clinics.

The type of incision to be used in performing an appendectomy is felt to have some prognostic significance in cases which have perforated. Dr. Collins (14) feels that muscle splitting incisions should be used whenever possible, and he attributes several of the deaths occurring in the series of cases he has reported, as being due to non-muscle splitting incisions. Dr. H. H. Davis and Dr. J. D. Bisgard, both of our University staff, advocate the use of the McBurney incision whenever possible, because when such an incision is used and perforation has occurred, the operator cuts down lateral to the area of local soiling and the field of operation is fairly easily limited to the cecum and
perhaps terminal ileum. This inhibits the tendency to generalized spread of the infection. In contrast to this, if a rectus incision is used and perforation has occurred, infected material may be dragged across the clean small intestine in order to deliver the appendix into the incision. In suspected abscess cases, when the actual position of the abscess cannot be determined preoperatively, an exploratory celiotomy incision near the midline may be made, but when the abscess is located and is not directly beneath this exploratory wound, it is not to be disturbed through this incision, but this incision is closed and another is made over the site of the abscess in order to establish optimum drainage.

The treatment of acute appendicitis depends upon the opinion of the individual surgeon relative to the treatment he feels is indicated in the various stages of the disease. Each case must be considered from the standpoint of the degree to which the disease process has progressed. These various degrees of progress of the disease process may be classified as non-perforated, recently perforated with local soiling, perforated for some time with diffuse peritonitis, perforated for several days with abscess formation, and moribund. It may be generally stated that practically all surgeons agree that every case of acute appendicitis seen before perforation has occurred, should be operated immediately if the patient's condition will permit
operation, and most agree that when the appendix has just perforated and soiling is local, it is better to operate. It is also agreed that abscesses should be drained, at least after they are well established, and there are few men who wish to operate a patient who is moribund. (18),(41),(58)

There is, however, considerable argument concerned with the management of cases with diffuse peritonitis. Some very excellent surgeons feel that every case of acute appendicitis should be operated as soon as possible after the patient is seen, regardless of whether or not the process is in the stage of diffuse peritonitis. Another group of surgeons have found that if they apply a different program to those cases having diffuse peritonitis, the mortality rate for these cases diminishes. Dr. Adams (2) and his associate, Dr. Bancroft, have reported a series of 110 cases of appendical peritonitis treated conservatively with rest, continuous gastroduodenal siphonage, hot applications to the abdomen, para-oral fluids and sedatives. They state that a deferred appendectomy is imperative in every case. Their mortality rate for this series was 4.5%. Death occurred in patients whose symptoms prior to the institution of treatment had persisted for from 39 to 96 hours. Dr. H. H. Davis outlines a similar regime of treatment in these cases and adds that if the Fowler position is used and an abscess forms, the abscess is more apt to be accessible to surgical drainage than if the patient
remains flat in bed and develops a subdiaphragmatic abscess. In his study of 960 cases of acute appendicitis, 173 of which had ruptured, there were 17 cases of diffuse peritonitis which were operated and 10 of them, or 58.8%, died. In 14 other cases of diffuse peritonitis the conservative management was instituted, and death occurred in 2 cases, or 14.3%.

The type of incision used in performing an appendectomy has been discussed previously, but it must be remembered that the operator's choice of incision may have considerable bearing on the morbidity and mortality rate of his patients.

The treatment of the appendical stump has received considerable attention. Many operators, if the case is clean, ligate the stump and invert it with a purse string suture. Others ligate the stump, but do not invert it, whether the case is clean or not. Dr. Ochsner (44) states that inversion without ligation technic is the ideal appendectomy procedure provided the stump can be inverted without contamination of the peritoneal cavity and provided that hemostasis can be secured. He and his associates state that with such a technic, there is no danger of subsequent inflammation occurring around the stump and extending to the cecal wall or peritoneal cavity.

In cases in which it cannot be decided definitely in the early stages of the disease whether one is dealing with acute appendicitis or an early pneumonia, one may be justified in
waiting. Such patients should be kept in bed, preferably in the Fowler position, the fluid balance should be maintained and no sedatives should be administered because of the possibility of masking the symptoms when they develop. (18),(60)

For a more detailed discussion of the operative technic and postoperative management of acute appendicitis, the reader is referred to Dr. Dean Lewis' Practice of Surgery and to Dr. Brennemann's Practice of Pediatrics.

Chronic appendicitis in children is encountered less frequently than acute appendicitis and is more apt to occur in patients over ten years of age. Some authors do not recognize the existence of chronic appendicitis as such, while others feel that chronic inflammation of the appendix is a pathological entity. (37),(52) Other terms, such as recurring acute appendicitis, appendicosis and chronic appendicopathy have been suggested as more descriptive of the condition.

The etiological background for the symptoms and physical changes of this condition includes chronic inflammation of the appendix, adhesions, fecoliths, kinks, scars, lymphoid hyperplasia, dilatation of the cecum and congenital bands and membranes about the cecum, ascending colon and hepatic flexure. (10),(52),(58)

The symptoms of chronic appendicitis are variable and may be referred to other structures in the abdomen. Dull, aching
pain in the right lower quadrant occurring daily may be a prominent symptom, or there may be no pain at all. Often patients are unable to give an accurate description of their symptoms or to give them an exact location. Tenderness may be localized to the region of the cecum or may be diffuse. The patient may complain of indigestion, borborygmus or constipation. Sometimes the symptoms are aggravated by exercises such as lifting, bending or stretching. Vomiting may or may not be a prominent symptom. If it can be obtained, the history of the initial attack may be of considerable value in leading to a diagnosis. \(19,37,49\)

The findings in cases of chronic appendicitis may be as variable as the symptoms. Dr. Wright (58) states that tenderness over the appendix is the exception rather than the rule and that pressure over the appendix produces pain elsewhere in the abdomen. He lists tympany over the right side of the abdomen as a suggestive finding and states that it is due to relaxation of the walls of the cecum and colon.

The diagnosis of chronic appendicitis is often very difficult, unless the case is that of a recurrent acute appendicitis with typical symptoms and findings. The diagnosis is based on a correlation of the symptoms and findings, and a history of a typical initial attack of acute appendicitis is helpful. \(37\)

X-ray studies of the colon may reveal segmenting or apparent non-filling of the appendix, but the latter cannot be depended on too
strongly because of the occasional retrocecal position of the appendix. Dr. DelValle (19) suggests the following maneuver as a valuable aid in the diagnosis of chronic appendicitis presenting atypical symptoms, especially in cases in which abdominal pain is not one of the complaints. This maneuver consists of gentle massage over the iliac fossa, which is performed while the patient's abdominal muscles are relaxed and which is repeated for two or more consecutive days. The presence of pain on the first examination of the patient contraindicates massage. If chronic appendicitis is present, pain at McBurney's point appears in the course of the treatment, spontaneously or during palpation. After the massage, the temperature rises slightly, there is an increase in the leukocyte count and the patient complains of right lower quadrant pain. At operation the appendix usually shows inflammation. The patient's symptoms usually disappear after an appendectomy has been performed.

In the differential diagnosis of chronic appendicitis, one must think of spasticity of the colon and cecum, diseases of the liver and spleen, diverticulitis, regional ileitis, tuberculosis of the cecum, occult hernia, diseases of the urinary tract, Herpes Zoster, herniated intervertebral discs and spinal cord tumors causing referred abdominal pain.

The prognosis of chronic appendicitis is chiefly concerned with the alleviation of the symptoms, and depends largely
on the pathological conditions found at operation, the duration of the history of attacks and the degree to which the symptoms and findings are localized. (52) If any of the pathological conditions listed above are found at operation and are corrected, the percentage of cures is fairly good. If the history of recurring attacks covers a period of one year or less, the prognosis is better than if these attacks have been recurring for a greater length of time and the more localized are the symptoms and findings, the better is the expectation of a cure.

If one is dealing with recurring acute appendicitis, which probably does not really belong in this group of chronic appendicitis or chronic appendicopathic conditions, the symptoms, findings, prognosis and treatment are essentially the same as for acute appendicitis proper.

The treatment for chronic appendicitis is appendectomy. Dr. Bigelow (10) in a series of cases all ready having undergone appendectomy without relief of symptoms, removed all so-called congenital bands and membranes from the cecum, ascending colon and hepatic flexure and reported a 92% cure. Dr. H. H. Davis has told us that plication of the cecum for three or four inches at the time of operation may aid in the alleviation of symptoms, since it is felt that dilatation of the cecum may be responsible for right sided pain.
A study was made of the case records of 137 children between the ages of 13 months and 13 years who entered the University Hospital with an admitting diagnosis of appendicitis.

Of this series, there were 94 cases of acute appendicitis, 20 cases of so-called chronic appendicitis, and the diagnosis was incorrect in 23 instances. An operation was performed in 110 cases, confirming the diagnosis of acute appendicitis in 89 cases and of chronic appendicitis in 16 cases. The diagnosis was missed in the other 5 cases. In one case of acute appendicitis, diagnosis was made at the necropsy table. This patient was a mentally retarded girl aged 13 months who entered the hospital with mastoiditis and who was in a severe state of malnutrition and dehydration. She had been ill for six weeks prior to admission. She evidently developed acute appendicitis while in the hospital, but at no time did she present any of the symptoms of acute appendicitis except vomiting, which was credited to the mastoiditis. She was operated for this condition. Her temperature was high, ranging between 101 and 105 degrees. During the last few days of life, she developed evidence of intestinal obstruction, but the true etiology of this complication was unsuspected. Autopsy revealed an acutely inflamed appendix which had perforated, an abscess, and evidence of peritonitis.

Perforation of the appendix occurred in 36, or 38.3% of the acute cases. All but two of these were operated, and the
findings at operation revealed 6 cases of recent perforation with local soiling of the peritoneum, 16 cases with varying degrees of generalized peritonitis, and 14 cases in which localized abscesses had developed.

In the 6 cases with recent perforation and local soiling, operation was performed immediately and the appendix was removed. In the 16 cases of generalized peritonitis, 10 were operated immediately and the appendix was removed in 7 instances. In 3 cases, drainage was instituted but no attempt was made to remove the appendix at this time although it was removed at a subsequent operation. In 4 cases the Ochsner treatment was employed for a number of days until it was felt that an abscess had developed and had become well walled off. The appendix was then removed. In one case, the Ochsner treatment was instituted and an abscess developed and absorbed. This patient was dismissed and instructed to return at a later date for an appendectomy. In one case, that of the 13 month old child, no treatment for appendicitis was employed, since the case was undiagnosed until autopsy. In the 14 cases with definite abscess formation, 7 cases were drained at the first operation and the appendix was removed later. In the other 7 cases, conditions found at operation were such that the appendix could be removed and drainage instituted at a single operation.

Death occurred in 5 of the perforated cases and in none
of the cases which had not perforated. The mortality rate for
the perforated cases was 13.9%, which brought the death rate for
the entire group of 94 cases of acute appendicitis to 5.3%.
Three deaths occurred in the cases with abcesses, and the other
two deaths occurred in cases with diffuse peritonitis. Death was
believed to be due to sepsis associated with a long sinus abcess
in one case, and to profound toxemia associated with a pelvic
abcess from which hemolytic streptococci were cultured in another
case. The other death in those cases with abcess resulted from
a combination of toxemia and thrombophlebitis of the right iliac
vein associated with small pulmonary emboli. In the diffuse
group, one case died of a hemolytic streptococcic peritonitis
associated with toxemia and the other death was that of the 13
month old child previously discussed.

Treatment of the clean cases of acute appendicitis
consisted of immediate operation except in three cases. In all
three the clinical picture was that of subsiding acute appendicitis.
One of these cases was so much improved in less than an hour after
entrance that operation was delayed and after observation of the
case for two days it was decided that operation was not warranted.
Another of these children had diphtheria, so operation was deferred,
and the other case was found to have pyelitis associated with a
subsiding appendicitis. These children all lived here in Omaha
so were instructed to return to the hospital in the event that.
they should have any further attacks.

Treatment in the chronic cases consisted of appendectomy in 16 instances, and in the other 4 cases it was felt that operation was not warranted.

The diagnosis was missed in 5 of the cases operated for acute appendicitis. One of these cases was that of a pneumococcic peritonitis. The temperature was 104.4 degrees on entrance, and the leukocyte count was 43,400. X-rays of the chest were negative. The child had been ill for 10 days and it was felt that a generalized peritonitis following perforation of the appendix was present. Operation revealed the true condition. The patient recovered.

Two cases gave a history of pain and nausea. Vomiting occurred in one of these. The leukocyte counts were 9,200 and 7,600. The temperatures on admission were 99.4 and 99.2 degrees. Physical examination revealed slight tenderness in the right lower quadrant and it was felt that appendectomy would be the safest procedure. Both appendices were negative. Both cases recovered.

In one case, the final diagnosis was lobar pneumonia. When first seen the patient presented the picture of a recently ruptured appendix. The patient had a history of pain, nausea and vomiting for three days duration. The abdomen was tender, and it was felt that some muscle spasm was present. The child had been given a cathartic. The leukocyte count was 15,000 and the temperature was 101.2 degrees. At operation the appendix was found to be
negative and in the course of the next few days, the correct diagnosis was made. This child recovered.

At operation, one case was found to have a negative appendix but an inflamed gall bladder which contained stones. The history and the physical findings were consistent with a diagnosis of acute appendicitis and the child had been given a purgative. The patient recovered.

In 18 cases the admitting diagnosis of appendicitis was ruled out by further studies of the cases. A diagnosis of gastro-enteritis was finally made in 4 of these, 2 of which had histories consistent with a diagnosis of acute appendicitis but with atypical findings. The other 2 cases presented histories and findings which were atypical from the standpoint of appendicitis. There were 4 cases of upper respiratory infections, including 2 common colds. Appendicitis had been suspected in these because of the presence of abdominal pain. Three cases were found to have tonsillitis associated with abdominal pain. One case with vague abdominal distress and vomiting developed an otitis media. One case was dismissed as an undiagnosed psychosis. Another case was found to have bronchiectasis. Another case was finally diagnosed marasmus, although it was felt at one time that there might be an associated pyelitis.

There was one case in which a diagnosis of chronic appendicitis was considered, but it was felt that the probable condition was
that of a mesenteric lymphadenitis. One patient complained of abdominal pain occurring every month, and since this patient was a girl 12 years of age, the possibility of ovulation as a basis for this symptom was considered. In one case which complained of some abdominal pain, the only findings were hypertrophied tonsils and rather marked constipation.

Tuberculous peritonitis complicated one of the cases of acute appendicitis. At operation the appendix appeared to be scarred, and this condition was reported by the pathologist, but no mention of tuberculosis was made in the pathology report. This patient recovered. In one of the cases that died, evidence of pulmonary tuberculosis was found at autopsy.

Pinworms were found in the appendices in two instances, but there was no perforation in either case, and both patients made an uneventful recovery.

Fecoliths were reported in 12 of the cases operated, and in 7 of these, perforation had occurred.

In 16 instances, the appendix was gangrenous, and perforation had occurred in 12 of these. The appendix of one of the patients that died was gangrenous and contained a fecolith, and in one of the other deaths, a fecolith was found in the appendix.

There were two cases associated with trauma. In one of these, the patient, a 12 year old boy, had dropped a baseball bat
and the handle struck him in the right lower quadrant of the abdomen as he started to run. The other case was that of a girl who fell from a swing. There is not enough known relative to the severity of the trauma in this case, to be sure that it was an etiological factor in producing her attack of appendicitis. Perforation of the appendix occurred early in both of these cases.

The age incidence of both acute and chronic appendicitis in this series was as follows:

<table>
<thead>
<tr>
<th>Age</th>
<th>Males</th>
<th>Females</th>
<th>Age</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 months</td>
<td>0</td>
<td>1</td>
<td>8 years</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>3 years</td>
<td>1</td>
<td>0</td>
<td>9 &quot;</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>4 &quot;</td>
<td>0</td>
<td>2</td>
<td>10 &quot;</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>5 &quot;</td>
<td>2</td>
<td>2</td>
<td>11 &quot;</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>6 &quot;</td>
<td>3</td>
<td>1</td>
<td>12 &quot;</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>7 &quot;</td>
<td>7</td>
<td>6</td>
<td>Total</td>
<td>54</td>
<td>60</td>
</tr>
</tbody>
</table>

Of the acute cases, 46 had upper respiratory infections prior to the onset of the symptoms of acute appendicitis. Of the chronic cases, 5 had a history of preceding upper respiratory infections, 4 of which were tonsillitis.

The duration of symptoms in the cases of acute appendicitis prior to hospitalization was as follows:

<table>
<thead>
<tr>
<th>Group</th>
<th>24 hours or less</th>
<th>1 to 3 days</th>
<th>Over 3 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-perforated</td>
<td>24</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Perforated</td>
<td>8</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>
Of the 8 cases in the perforated group with symptoms of a duration of 24 hours or less, two had perforated within 18 hours and one had perforated within 6 hours.

Abdominal pain was the initial symptom of the attack in all but four of the acute cases. In one of these, the 13 month old child, no evidence of abdominal pain was observed. In the other three cases, it was said to have followed an attack of vomiting but in one of these, it was also stated that the pain was first noted in the right lower quadrant, so the initial generalized or epigastric pain might have been overlooked by the child's mother. In eight cases, the pain was said to have been noticed in the right lower quadrant at first, but it may be of some significance that five of these children gave a history of having had similar attacks of pain previously.

Nausea was present in all but 12 of the acute cases. In one of these its presence was not recorded, and in the 13 month old child, its presence could not be proved although the child did vomit. Vomiting was absent in 13 cases, including 11 of the cases which had no history of nausea. In one instance its presence was not recorded. In 4 of the cases in which both nausea and vomiting were absent, there were histories of previous attacks, and a history of previous attacks was noted in one of the cases which was nauseated but did not vomit.

Tenderness was a persistent finding in all but five of
the acute cases. It was reported as being absent in one abscess case, and no mention of its presence was made in the case of the 13 month old infant. Tenderness was not recorded in three of the cases which had perforated. The finding was said to be slight in three of the non-perforated cases.

Rigidity was recorded as slight in 11, moderate in 12, and marked in one of the cases in the unperforated group, and in the perforated group it was not listed as a finding in 13 cases, was recorded as slight in one case, was recorded as marked but localized in 16 instances, and was generalized in 7 cases.

Previous attacks were recorded in the histories of 32 of the cases proven to be appendicitis.

A definite history of catharsis was recorded in 29 of the charts of the acute cases, and perforation had occurred in 17 of these. There was no record relative to the administration of cathartics in 16 of the cases of acute appendicitis. Death occurred in two instances where cathartics had been administered.

The ranges in temperature for the acute cases were as follows:

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Clean Cases</th>
<th>Perforated</th>
<th>Temp.</th>
<th>Clean</th>
<th>Perf.</th>
</tr>
</thead>
<tbody>
<tr>
<td>98.6-98.8</td>
<td>9</td>
<td>1</td>
<td>101.0-101.8</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>99.0-99.8</td>
<td>25</td>
<td>4</td>
<td>102.0-102.8</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>100.0-100.8</td>
<td>15</td>
<td>5</td>
<td>103.0-103.8</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

Of the two high fevers in the non-perforated group, one
occurred in the case with tuberculous peritonitis. There was no clinical explanation for the other high fever.

The leukocyte counts and differential counts showed considerable variation. These were done on each patient shortly after admission. The results of a study of these findings for the acute non-perforated group, the perforated group, and the chronic group are shown below.

<table>
<thead>
<tr>
<th>Non-perforated</th>
<th>Perforated</th>
<th>Chronic</th>
</tr>
</thead>
<tbody>
<tr>
<td>High WBC</td>
<td>37,000</td>
<td>43,900</td>
</tr>
<tr>
<td>Low WBC</td>
<td>7,600</td>
<td>10,000</td>
</tr>
<tr>
<td>High % Polys</td>
<td>95%</td>
<td>98%</td>
</tr>
<tr>
<td>Low % Polys</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>Average WBC</td>
<td>15,000</td>
<td>19,800</td>
</tr>
<tr>
<td>Average % Polys</td>
<td>75%</td>
<td>81%</td>
</tr>
</tbody>
</table>

Although this series of cases is too small to draw any accurate conclusions, its study has emphasized a number of points brought up in the preceding discussion of the subject.

The fact that there were no deaths in the unperforated group and five deaths in the perforated group certainly emphasizes the old and often repeated observation that, to reduce the mortality of acute appendicitis, operation must be performed soon after the onset of symptoms and the finding that cathartics had been administered to nearly half of the cases that perforated
and to only 22% of the unperforated cases, seems to back up the statement that catharsis is definitely one of the factors responsible for early perforation.

The finding that pain was the initial symptom in 95% of the acute cases and that pain was a prominent complaint in all but one case bears out the statements made previously relative to the importance of pain as one of the cardinal symptoms of acute appendicitis.

Nausea and vomiting were not present as consistently as pain, but even so one or both symptoms were present in all but twelve of the acute cases, and this small number included one instance in which neither symptom was recorded and four cases with histories of previous attacks.

Tenderness was present in all but five cases, in three of which its presence or absence was not recorded and in only one instance was it definitely recorded as absent.

It has been observed that temperatures and leukocyte counts are both somewhat elevated in cases of acute appendicitis and that in perforated cases they are both higher than in the simple acute cases. The findings in this series are consistent with these observations.

The ease with which other conditions may be confused with acute appendicitis has been brought out by the observation that the diagnosis was missed in five of the cases operated and
by further observation that eighteen of the other patients admitted with a diagnosis of appendicitis on further examination were found to be suffering from some other condition.

In conclusion, it may be stated that the prevention of the development of complications and the mortality rate which accompanies these complications in acute appendicitis depends upon early diagnosis, withholding the administration of laxatives, and early institution of proper treatment.

Early diagnosis depends first upon the patient or his family, who must be educated to summon a physician early in the course of the disease. Secondly, acute appendicitis should always be ruled out in every case of abdominal pain and in every case of vomiting that occurs in children. A carefully taken history and a complete physical examination are the most valuable aids to the diagnosis of this disease and the four cardinal symptoms and findings of acute appendicitis should be remembered because they are usually present. It is granted that the diagnosis of acute appendicitis in young children may be most difficult, and it might be well to consider the opinion of Dr. Bastianelli, whom Dr. Skrentney feels is a conservative surgeon and whom he quotes as stating that, "When physicians are discussing whether the case is appendicitis or not, it is. When they are inclined to admit the possibility of appendicitis without being sure,
it not only is, but is about to perforate. When the diagnosis is sure, there is all ready perforation with more or less circumscribed peritonitis." (53) It may be added that in the opinion of most surgeons, when the diagnosis is doubtful, it is much safer to open the abdomen and remove an innocent appendix than it is to risk the danger of perforation and its complications. Dr. McClanahan (40) states that an appendix in a bottle is safer than an appendix in the abdomen.

The danger of the administration of laxatives in cases of acute appendicitis has been made clear to members of the Medical profession, but the lay public should be educated more accurately in regard to such self medication. (39) As a step in this direction, the Medical Society of New Jersey has set up an annual campaign to reduce the mortality rate of acute appendicitis and issues stickers to schools to be distributed among the school children. These stickers warn the children not to take cathartics when they have abdominal pain. Placards bearing the same warning are issued to pharmacists who are urged to display them prominently in their places of business. A general adoption of a similar campaign might produce an appreciable reduction of the mortality rate of acute appendicitis.
I wish to express my appreciation to the members of the University staff for the assistance they have given me both through personal interviews and class lectures, relative to the subject which I have attempted to discuss, and I particularly wish to thank Dr. Hamilton for the valuable suggestions he has given me relative to the subject and to the construction of this presentation.


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