5-1-1939

Appendicitis in children

John E. Patton

University of Nebraska Medical Center

This manuscript is historical in nature and may not reflect current medical research and practice. Search PubMed for current research.

Follow this and additional works at: https://digitalcommons.unmc.edu/mdtheses

Part of the Medical Education Commons

Recommended Citation

APPENDICITIS IN CHILDREN

JOHN E. PATTON

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 infrequence 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 ap-
pendix, but a careful search may reveal that it is retroperit-
oneally 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
of the appendix are its general shape and its histological struct-
ure. 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 appen-
dix 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 diffi-
culty in diagnosis.

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

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:

January	8 cases	May	12 cases	September	10 cases
February	6 cases	June	14 cases	October	3 cases
March	7 cases	July	15 cases	November	3 cases
April	4 cases	August	15 cases	December	7 cases

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. Aschoff 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 peritonitis 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 con-
sidered 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 intussus-
ception 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 appen-
dix. 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, al-

though 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 contrac-

tile 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 ileocecal 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 appendicecal 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 ileocecal region is due to variations in embryologic development". (15)

The prevalence of appendicitis following an acute respiratory 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 appen-
dix 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 pro-
cess 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 in-
frequent cause, must nevertheless be considered one of the pri-
mary 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, result-
ing in forcing fecal material into the appendix with such force
that changes within the mucosa occur, and an attack of appendi-
citis 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),

(24),(50)

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 appen-
dicitis, the appendix is not involved alone, but the mesentery
of the organ is also involved. Dr. Beluffi (9) after microscop-
ic 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 cir-
culation take place and may be complicated by venous thrombo-
sis and, in rare cases, by suppurative thrombophlebitis or
liver abscess. After regression of acute appendicitis, the
appendicular mesentery shows structural changes which are per-
manent 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 ob-
structions, 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 con-
dition. Such an appendix, if suddenly occluded, would surely
be more prone to rupture than would a previously normal appen-
dix. 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 gen-
eralized 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 ob-
struction of the appendical lumen producing mechanical inter-
ference with normal peristalis, 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, sleep-

lessness, 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 move-

ments 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 success-

ful 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
retrocecally, 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 devel-
opment of the typical localized pain. The position of the ap-
pendix 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, tenderness 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 appendicitis in adults. Rigidity also developes 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 pathologi-
cal process, there are many cases in which the temperature can-
not 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 Univer-
sity, the average white count in proven cases of acute appendi-
citis 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 nonfilament-
ed 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 de-
veloping on the second or third day of the attack, and associat-
ed 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 inflammed 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
may be inaccurate because she will stress the conditions which
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 ques-
tioning 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 coopera-
tion 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 propor-
tion to the acuteness and extent of the infection, and is in-
fluenced 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 with-
out 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 land mark. 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-

cecal, 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 local-
ized 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 of 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 sternocleidomasteid 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 appen-
dicitis 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 con-
stant 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 stethescope, 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 Koplik'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 class-
ical 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 intestional 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 character-
ized 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 obstruc-
tion, 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 posi-
tion 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 appen-
dicitis 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 character-
ized by forceful vomiting following shortly after the ingestion
of food, visible peristalic 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 occuring 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 con-

dition 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 consider-

ing the types of appendicitis which this condition might simulate,

that associated with trauma would probably offer the most diffi-

culty 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 procedes so rapidly. (1),(8),(27)

Tuberculosis of the spine and hip may offer some con-

fusion 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 ab-
dominal pain, rather obstinate constipation, occasional vomiting
and later in the disease, a marked secondary anemia. (40) Occas-
ionally 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 appen-
dix. 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 thrombo-
phlebitis 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 loca-
tion 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 ab-
domen, being directed there by the root of the mesentery. Pelvic
abscesses may arise. These are usually detected by rectal ex-
amination 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 jaundice, 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 occuring from appen-
dicitis. 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 appen-
dicitis in which symptoms of septic thrombosis of the liver are
present. (28),(37)

Pulmonary embolism occurs occasionally in acute appen-
dicitis 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 pulmonaryembolism 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 perfor-

ated. 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 5.3%, 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 spread-

ing peritonitis had a mortality rate of 17.4%. Death was due to

profound toxemia, pneumonia, paralytic ileus and pulmonary em-

bolism. 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 re-

sponsible 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 un-

perforated 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 ad-
ministration 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 numer-
ous 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 dis-
lodge such a belief because, in the first place, purgative medi-
cation 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 all ready
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 append-
ectomy is felt to have some prognostic significance in cases
which have perforated. Dr. Collins (14) feels that muscle split-
ting 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 abcess cases, when the
actual position of the abcess cannot be determined preoperatively,
an exploratory celiotomy incision near the midline may be made,
but when the abcess 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 abcess 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 precess may be classified as non-
perforated, recently perforated with local soiling, perforated
for some time with diffuse peritonitis, perforated for several
days with abcess 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 per-
forated and soiling is local, it is better to operate. It is
also agreed that abcesses 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 dif-
fuse 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
seried of 110 cases of appendical peritonitis treated conserva-
tively with rest, continuous gastroduodenal siphoriage, hot appli-
cations 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 abcess forms, the abcess is more
apt to be accessible to surgical drainage than if the patient

remains flat in bed and develops a dubdiaphragmatic abcess. 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 appendi-

citis, 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 excercises 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 perforemd.

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 con-
ditions listed above are found at operation and are corrected,
the percentage of cures is fairly good. If the history of re-
curring attacks covers a period of one year or less, the prog-
nosis is better than if these attacks have been recurring for
a greater length of time and the more localized are the symp-
toms 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 gropp 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 abcess, 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 abcesses 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 abcess had developed and had become well walled off. The appendix was then removed. In one case, the Ochsner treatment was instituted and an abcess 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 abcess 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 appendi-
citis. 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:

Age	Males	Females	Age	Males	Females
13 months	0	1	8 years	6	7
3 years	1	0	9 "	8	5
4 "	0	2	10 "	9	8
5 "	2	2	11 "	11	14
6 "	3	1	12 "	8	14
7 "	7	6	Total	54	60

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:

Group	24 hours or less	1 to 3 days	Over 3 days
Non-perforated	24	22	12
Perforated	8	14	14

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 abcess 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:

Temperature	Clean Cases	Perforated	Temp.	Clean	Perf.
98.0- 98.8	9	1	101.0-101.8	7	14
99.0- 99.8	25	4	102.0-102.8	0	6
100.0-100.8	15	5	103.0-103.8	2	6

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.

		Non-perforated	Perforated	Chronic
High	WBC	37,000	43,900	11,000
Low	WBC	7,600	10,000	5,800
High % Polys		95%	98%	81%
Low % Polys		60%	60%	41%
Average WBC		15,000	19,800	8,000
Average % Polys		75%	81%	58%

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 diag-
nosis of acute appendicitis in young children may be most diffi-
cult, 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 in-
clined 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 compli-

cations. 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 appen-

dicitis 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 dis-

play 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.

BIBLIOGRAPHY

1. Abell, Irvin, Acute Abdominal Catastrophies,
   Jour. A.M.A., 109:1241 (1937)

2. Adams, J. M., and Bancroft, P. M., Conservative Management
   of Appendical Peritonitis in Children,
   Jour. of Pediatrics, 12:298 (1938)

3. Allen, Philip D., Acute Appendicitis in Children,
   Jour. A.M.A., 109:121 (1937)

4. Angel, Furman; Angel, Edgar, and Kizinski, Alexander,
   Acute Appendicitis in Children, American J. of Surg.,38:268 (1937)

5. Aynsworth, K. H., Appendicular Colic in Childhood,
   Texas State Jour. of Med., 32:655 (1937)

6. Battaglia, A., and di Fiore, H., Appendicitis from Oxyuris
   Prensa Medica Argentina, 24:1349 (1937) Abstracted in Jour.
   A.M.A., 109:832 (1937)

7. Baumgartner, Conrad J., Appendicitis in Children, A Study of
   100 Consecutive Cases, Archives of Pediatrics, 50:571 (1933)

8. Bell, Richard P., Cases in Children Simulating Acute Appendicitis
   International Clinics, 47th Series, 4:170 (1937)

9. Beluffi, E., Appendicular Mesenteriolitis,
   Archivo Italiano di Chirurgia, 48:697 (1938) Abstracted in
   Jour. A.M.A., 111:978 (1938)

10. Bigelow, W. A., Solution to Mystery of Chronic Appendicitis,
    Canadian Med. Ass'n. Jour., 38:36 (1938) Abstracted in
    Jour. A.M.A., 110:771 (1938)

11. Bower, J. A., Mengle, H. A., and Paxon, N. F., Demonstration
    of Antitoxin for Toxin of Clostridium Welchii in the Blood
    Serum of Patients and Dogs That Have Recovered from Spreading
    Peritonitis Complicating Acute Perforative Appendicitis.
    Jour. of Immunology, 34:185 (1938) Abstracted in Jour. A.M.A.,
    110:1708 (1938)

12. Brennemann, Joseph, Practice of Pediatrics, Vol. 3, Ch. 6, p-40
    Hagerstown, Md., W. F. Prior Co., (1937)

13. Burgess, C. M., Traumatic Appendicitis, Jour. A.M.A. 111:699
    (1938)

14. Collins, D. C., Acute Retrocecal Appendicitis Based on 751
    Instances. Archives of Surg., 36:729 (1937)

15. Connell, F. G., Etiology of Appendicitis.
    American Jour. of Surg., 37:232 (1937)

16. Crohn, Burrill B., The Prognosis of Regional Ileitis.
    New Jersey Med. Soc. Jour., 34:320 (1937) Abstracted in
    Jour. A.M.A., 109:169 (1937)

17. Crohn, Burrill B., and Berg, Albert A., Right Sided (Regional)
    Colitis. Jour, A.M.A., 110:32 (1938)

18. Davis, B. B., Why is the Mortality of Appendicitis Increasing?
    Nebraska State Med. Jour., 16:41 (1931)

19. Del Valle, D., and Giordano, A., Atypical Chronic Appendicitis:
    Maneuver for Diagnosis. Archives Arg. de Enf, del Ap. Digest.,
    12:573 (1937) Abstracted from Jour. A.M.A., 109:2024 (1937)

20. Edwards, Harold C., Surgical Emergencies in Children, Ch. 10,
    p-111, and Ch. 11, p-150.

21. Flannery, W. E., Appendicitis at the Jameson Memorial Hospital.
    Archives of Surg., 36:977 (1938)

22. Fowler, Royal D., Trauma and Appendicitis.
    Jour. A.M.A., 111:699 (1938)

23. Gentile, Antonio, Partial Prolapse of the Cecum. Ileum, and
    Appendix Through a Preformed Opening in the Greater Omentum.
    Jour. A.M.A., 101:927 (1933)

24. Goodyear, Emil S., Traumatic Appendicitis.
    Jour. A.M.A., 111:1788 (1938)

25. Gray, Henry, Anatomy of the Human Body, ed. 22, p-1171
    Philadelphia and New York, Lea & Febiger, (1930)

26. Gray, S. H., and Heifetz, C. J., Lymphoid Hyperplasia of
    the Appendix. Archives of Surg., 35:807 (1937)

27. Hardy, John A., Synopsis of the Diagnosis of the Acute
    Surgical Diseases of the Abdomen. Ch. 21, p-169, also pages
    86, 116-120, 177, 195, 204, 206, 307, and 330.
    St. Louis, C. V. Mosby Co. (1938)

28. Hawkes, S. Z., Thrombophlebitis of Appendical Vein Compli-
    cating Acute Appendicitis. Surg., Gyn. and Ob., 66:62 (1938)

29. Heyl, James H., Acute Appendicitis in Infants and Children
    Under Five Years of Age. N.Y. State Jour. of Med., 36:332 (1936)

30. Hodgson, J. C., Regional Ileitis: Crohn's Disease.
    Lancet, 1:926 (1937)

31. Horsley, John S., Acute Appendicitis in Children
    Virginia Med. Monthly, 59:165 (1932)

32. Jackson, A. S., Regional Enteritis: Report of Five Cases.
    Wisconsin Med. Jour., 36:632 (1937) Abstracted in Jour. A.M.A.
    109:1079 (1937)

33. Jirka, F. J., and Scuderi, C. S., Mucoceles of Appendix.
    Ill. Med. Jour., 73:57 (1938) Abstracted in Jour. A.M.A.
    110:930 (1938)

34. Jones, Rudolph J., and Menefee, Elijah E., Acute Appendicitis
    in Childhood. American Jour. of Surg., 37:446 (1937)

35. Kirschenmann, John J., Appendicitis in Children.
    American Jour. of Surg., 16:318 (1932)

36. Lawen, A., Fibroplastic Appendicitis, Chronic Stenosing
    Terminal Ileitis and Nonspecific Inflammatory Ileocecal Tumors.
    Zentralblatt fur Chirurgie, 65:911 (1938) Abstracted in
    Jour. A.M.A., 111:109 (1938)

37. Lewis, Dean, and Firor, Warfield M., Appendicitis. From
    Christopher, Frederick, A Textbook of Surgery, p-1184.
    Philadelphia, W. B. Saunders Co., (1937)

38. Lintgen, C., and Fry, K., Evaluation of Sedimentation Test
    in Differential Diagnosis of Acute Pelvic Inflammatory Dis-
    ease and Acute Appendicitis.
    American Jour. of Ob. and Gyn., 36:393 (1938)

39. Martin, William F., Appendicitis in Children.
    Southern Med. and Surg., 94:518 (1932)

40. McClanahan, Harry M., Pediatrics for the General Practioner.
    p-194. Philadelphia, J. B. Lippincott Co. (1929)

41. McLanahan, Samuel, Acute Appendicitis in Children.
    American Jour. of Surg., 25:14 (1934)

42. Mills, Stephen D., Filamented-Nonfilamented Cell Count in Appendicitis in Children. American Jour. of Diseases of Children, 50:36 (1935)

43. Nixon, Sater, and Nixon, Byron, Acute Appendicitis in Children. American Jour. of Diseases of Children, 51:1297 (1936)

44. Ochsner, A., and Lilly, G., Technic of Appendèctomy, With Particular Reference to Treatment of Appendical Stump. Surgery, 2:532 (1937)

45. Oppenheimer, Gordon D., Recurrent or Residual Progressive Ileitis. Jour. A.M.A., 110:1103 (1938)

46. Pickhardt, Otto C., and Rafsky, Henry A., Problems Presented by Lesions of the Right Lower Quadrant. Jour. A.M.A. 109:2048 (1937)

47. Pounders, Carroll M., Appendicitis in Children. Southern Med. Jour., 24:686 (1931)

48. Richet, C., and Netter, H., New Sign of Appendicitis: Contraction of Adductors of Right Side. Paris Med. 2:317 (1937) Abstracted in Jour. A.M.A., 109:2023 (1937)

49. Rivers, Andrew R., and Mendes Ferriera, Antonio E. Incidence and Causes of Chronic Dyspepsia at Various Ages Jour. A.M.A., 110:2132 (1938)

50. Rogers, Ronald B., Trauma, Case Report. Jour. A.M.A., 111:1231 (1938)

51. Schmidt, E. R., and Joachim, F. G., The Student Health Problem of Appendicitis. Journal-Lancet, 58:329 (1938) Abstracted in Jour. A.M.A., 111:1714 (1938)

53. Skrentny, Stanley H., Acute Appendicitis in Childhood. Jour. of Ind. State Med. Ass'n., 29:122 (1936)

52. Shelley, H. J., Chronic Appendicitis: Is it a Clinical Entity? Archives of Surg., 37:17 (1938)

54. Stone, Caleb S., Jr., Acute Appendicitis in Children. Archives of Surg., 30:346 (1935)

55. Thieme, E. T., Primary Tuberculous Appendicitis and Appendicitis Complicating Pulmonary Tuberculosis. American Jour. of Med. Sc., 193:700 (1937) Abstracted in Jour. A.M.A. 109:163 (1937)

56. Von Mikulicz-Radecki, Role of Appendicitis in Pathogenesis
    of Female Sterility. Archiv fur Gynakologie, 166:327 (1938)
    Abstracted in Jour. A.M.A., 111:578 (1938)

57. Wangansteen, O. H., Buirge, R. E., Dennis, C., and Ritchie, W.P.
    Studies in Etiology of Acute Appendicitis.
    Annals of Surg., 106:801 (1937)

58. Wright, Thew, Appendicitis in Children.
    American Jour. of Surg., 21:397 (1933)

59. Wunder, Eleanore, Formation of Diverticula on Appendix.
    Frankfurter Zeitschrift fur Pathologie, 51:18 (1937)
    Abstracted in Jour. A.M.A., 109:1861 (1937)

60. Wyatt, Oswald S., Acute Appendicitis in Childhood.
    Minnesota Med., 17:138 (1934)