Peritoneal Drainage Versus Non-Drainage for Generalized Peritonitis from Ruptured Appendicitis in Children:

A Prospective Study

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THE RATES OF MORTALITY AND MORBIDITY of acute appendicitis have steadily declined since the precise identification of this disease process by Fitts in 1887.[3] The protean ways in which this disease may present itself, especially in young children and in the elderly, may frequently baffle the most experienced physician. Indeed, the pathogenesis of appendicitis remains obscure. The mortality of ruptured appendicitis is still excessively high, especially when the diseased organ can be easily excised without functional deficit. Intra-abdominal abscesses and generalized septicemia are the major causes of mortality from ruptured appendicitis. The most impressive gains in the management of this disease have come through adequate fluid and colloid replacement to correct losses into the inflamed peritoneal cavity, and powerful, specific antibiotic agents to help the patient heal the generalized purulent process.

One area of continuing controversy in the therapy of generalized peritonitis associated with ruptured appendicitis has been the use of peritoneal drainage in the management of gross peritoneal contamination and generalized purulent peritonitis. In adult patients, drainage has not been generally advocated because of a consensus that a drain rapidly becomes walled off and ineffective.[18] On the other hand, most children's surgeons have been insistent on the use of drainage, especially in infants and younger children in whom there may be less ability to localize infection and in whom drainage may be more effective because of their small peritoneal cavities.

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If transperitoneal drains effectively evacuate pus from the abdominal cavity, then their use should decrease morbidity and lower mortality in patients with generalized peritonitis associated with ruptured appendicitis. On the other hand, the potential hazards of secondary infection and foreign body complications may negate any theoretic advantages of peritoneal drainage. Immediate aggressive management with systemic antibiotics alone may be equally effective and would obviate potential complications of transperitoneal drainage.

To evaluate the efficacy of transperitoneal drainage in children with generalized peritonitis from ruptured appendicitis, we have carried out a double blind, prospective study which includes 43 patients in the last 6 years on the Children's Surgery Service of The Johns Hopkins Hospital. All other aspects of management in these patients, including antibiotic coverage and fluid and electrolyte replacements, were identical, except that transperitoneal drainage was used in children with even hospital numbers and no drainage or wound drainage alone was used in children with odd hospital numbers (Fig. 1). This paper reports the results of this study and the recommendations which have resulted from the data accumulated in this clinical survey.

Protocol for Management of Generalized Peritonitis Secondary to Appendicitis in Children 0–14 Years of Age

All children with generalized peritonitis from a perforated appendix were included in the study. Forty-

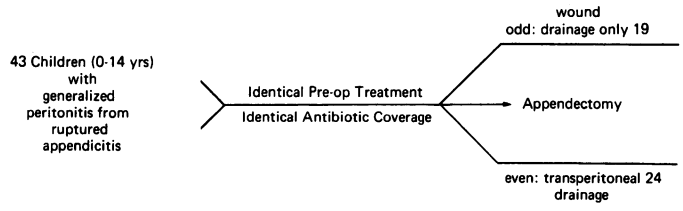

FIGURE 1.

three children with the clinical and operative findings of generalized peritonitis secondary to ruptured appendix were treated during the 6-year period, 1965–1971, and were managed in the same manner except for peritoneal drainage. Appropriate preoperative treatment with hydration preceded any operative management. In general, the patients' temperatures were below 38°C., and there had been optimal fluid and blood replacement before the child was anesthetized. All children with clinical evidence of generalized peritonitis received appropriate antibiotic agents preoperatively. Unless the patient had a history of specific drug sensitivity, the original regimen for peritonitis consisted of three medications: penicillin, chloramphenicol and streptomycin. Antibiotics were continued for a minimum of 10 days and longer when indicated.

Chloramphenicol was administered in a dosage of 100 mg./Kg./day divided into 6-hour doses. It was accompanied by Lactinex when given orally. The first dose was administered prior to operation or as soon as the diagnosis of generalized peritonitis was established. The drug was discontinued if the patient demonstrated a failure to respond to treatment, if he developed an adverse reaction to the drug, or if culture sensitivities indicated a more preferable antibiotic.

Penicillin was administered as aqueous penicillin, 200,000 units/Kg./day, given intravenously as long as the patient needed parenteral therapy. The period of therapy and indications for discontinuance of medications were similar to those for chloramphenicol.

Streptomycin was administered in doses of 30 mg./Kg./day, divided into two equal doses intramuscularly for a total of 5 days. This medication was limited to 5 days except in unusual circumstances because of concern about neural toxicity with prolonged use of the drug.

A careful review of the antibiotics and the drug sensitivities of the organisms cultured from the peritoneal cavities of these patients was carried out in 1968. This study showed that a more effective coverage of the bacterial flora of the peritoneal cavity was a combination of Keflin and kanamycin. Upon the recommendation of the Pediatric Infectious Disease Unit, the protocol was changed at this point, and Keflin and kanamycin became the standard initial antibiotic coverage for all patients in the protocol. This change occurred about midway in the study. The medications were applied to both groups of patients; therefore, it should not alter the statistical significance of the comparative groups. The recommended dosage for Keflin (cephalothin) was 250 mg./Kg./day and for kanamycin was 15 mg./Kg./day (Table 2).

TABLE 1

	No. of Pts.	Av. Age	Av. Hosp.	Complications: Major Abd.	Complications: Major Extra-Abd.	Deaths
Transperitoneal Drainage	24	7.5	17.9	3	1 pneu.	2
Wound Drainage	19	8.4	14.2	3	1 osteo.	0

Patients were operated upon through transverse skin incisions, and the abdominal cavity was entered through a muscle splitting incision. Peritoneal cultures were obtained in all patients at the time of operation. An appendectomy was carried out except in extremely unusual circumstances. The appendiceal stump was inverted beneath a purse string suture when the wall of the cecum was favorable for this maneuver; otherwise, the appendiceal stump was simply ligated with chromic catgut. The management of the appendiceal stump was not randomized in the study.

Patients with hospital numbers ending in even digits received transperitoneal drainage consisting of 2½ inch Penrose drains introduced through the lateral aspect of the incision into the pelvic floor and to the area of the cecum. In children with hospital numbers ending in odd numbers, peritoneal drainage was not employed. Instead, a short, ½ inch Penrose drain was placed into the mid portion of the incision down to, but not through the peritoneum. The transperitoneal drains were gradually removed over a period of not less than 7 days. The ultimate removal of a drain was determined by the degree of drainage and the patient's course. In patients with wound drainage alone, the drain was usually removed by 5 days.

All patients were managed in a Fowler's position postoperatively. Other forms of postoperative management were individualized, except as noted. A card file was maintained on all patients in the study to include morbidity; days in the hospital; days febrile; complications, specifically pelvic abscesses, subphrenic abscesses, intra-abdominal abscesses, and secondary wound infection. Pertinent data have been collated and are shown in Table 1.

Results

During the study period, 43 children between the ages of 1 and 14 years with generalized peritonitis from rup-

tured appendicitis were managed on the Children's Surgery Service of The Johns Hopkins Hospital. As shown in Figure 1, 24 patients received transperitoneal drainage according to the protocol, and 19 received wound drainage only. There were two deaths in the entire group; both occurred in the transperitoneal drainage group. Following is a brief description of the hospital courses of these two patients.

TABLE 2. *Antibiotics*

1965–1968	Chloramphenicol	100 mgm/Kg./day in q. 6 h. doses.
	Penicillin	200,000 u/Kg./day I. V.
	Streptomycin	30 mgm/Kg./day in q. 12 h. doses.
1968–1971	Keflin (Cephalothin)	250 mgm/Kg./day in q. 6 h. doses.
	Kanamycin	15 mgm/Kg./day in q. 12 h. doses.

Case Reports

Case 1 *(July, 1965).* A 2½-year-old boy was admitted with a 3-day history of vomiting, abdominal pain and green diarrhea. He obviously had diffuse peritonitis when first seen and was immediately prepared for operation. Admission white blood count was 18,500; X-ray revealed thickened loops of bowel but no definite fecalith. He was given penicillin, streptomycin and Chloromycetin. After 8 hours of replacement therapy, he was taken to the operating room. Through a McBurney incision, generalized purulent peritonitis was found with the release of 100 cc. of cloudy fluid. The appendix was removed and drains inserted into the pelvis and along the right gutter. For the first 2 postoperative days he seemed to be responding well, but on the third postoperative day his fever suddenly rose to 40 C., and was found to have a right lower lobe pneumonia. Pulse ranged between 160–180, and white count had risen to 30,000. A nasotracheal smear revealed pneumococci and the penicillin dosage was increased to 5 million units a day. On the seventh postoperative day he suddenly became unresponsive; blood pressure was not obtainable and he was given plasmanate, Levophed and Solu-cortef. He had several respiratory arrests, and 3 hours after the hypotensive episode he had a cardiac arrest from which he could not be resuscitated. Autopsy revealed generalized purulent peritonitis with a consolidated right lower lobe. Cause of death was determined to be gram-negative sepsis and shock secondary to generalized peritonitis from ruptured appendicitis.

Case 2 *(October, 1966).* A 4-year-old boy was admitted with generalized peritonitis and a 6-day history of vague abdominal pain. Four days prior to admission he had a temperature of 38 C. and one episode of vomiting. There was no abdominal tenderness at that time. He was not seen again until the day of admission when his temperature was 39.8 C. and his pulse was 200. There was evidence of generalized peritonitis with abdominal distention and absent bowel sounds. White blood count was 17,400 and the flat plate of his abdomen revealed generalized fluid with a fecalith in the right lower quadrant. After 4 hours of fluid replacement and administration of penicillin, Chloromycetin and streptomycin, he was taken to the operating room where a McBurney incision was made with the release of 400 cc. of frank pus from the peritoneal cavity. The tip of the appendix was ruptured and there was generalized purulent peritonitis. The appendix was removed and three drains were inserted; two in the pelvis and one along the right gutter. Postoperatively he had a pulse of 200 with a venous pressure of 2 cm. of water. He was given plasmanante infusion until his central venous pressure was 10. Pulse rate decreased to 170, but he continued to have a high fever and generalized lethargy. Nine hours after operation he suddenly became apneic and blood pressure was unobtainable. Cardiac and respiratory resuscitation were successful, but he never regained consciousness. He had a cardiac arrest on two more occasions, and was finally pronounced dead 16 hours after the operative procedure. The autopsy findings confirmed generalized purulent peritonitis. It was felt that the cause of death was gram-negative sepsis and shock secondary to ruptured appendicitis and generalized peritonitis.

The patients with transperitoneal drainage were hospitalized for an average of 17.9 days (if the two deaths are excluded), while those in the non-drainage group averaged 14.2 days. The average for the non-drainage group does not include one patient who developed osteomyelitis and required prolonged hospitalization for the complications of that disease. Thirty-three of the 43 patients were boys, an interesting sex preponderance of 70% males.

The bacterial cultures in the two groups showed a similar spectrum with a tremendous preponderance of *Escherichia coli* organisms. In practically all cases, the predominating organisms were highly sensitive to the combination of Keflin and kanamycin.

Wound infections were not considered as specific complications because all wounds, by definition, were contaminated, and transwound drainage was carried out in both groups. If a re-operation was necessary because of continuing or recurrent intra-abdominal infection, this was listed as a complication. Three patients in each group required re-operation for intra-abdominal abscesses or incomplete drainage. A major non-abdominal complication occurred in the transperitoneal drainage group: staphylococcal pneumonia which prolonged hospitalization. The pneumonia was unrelated to the organisms cultured from the abdomen. Another major non-abdominal complication occurred in the non-drainage group; namely, osteomyelitis due to *E. coli* organisms. Although several wounds in both groups needed occasional probing to enhance drainage, none required re-operation for abdominal wall drainage. Secondary wound closure was not carried out.

Discussion

Whether or not to utilize peritoneal drainage in patients with diffuse appendiceal peritonitis has been a subject of controversy for years. Halsted in 1898[6] made the comment that "no drainage at all is better than the ignorant employment of it". Indeed. Halsted pointed out some of the dangers inherent in the use of drains in the abdominal cavity and devoted many of his energies

to the development of a soft drain which could be used without danger of perforating adjacent abdominal organs. His statement was in contrast to Tait's dictum of 1887[15]—"when in doubt, drain," which had great influence on surgeons of the time. Unfortunately, as pointed out recently by Talbert and Zuidema,[16] no definitive data have yet been presented to settle the dilemma.

Most surgeons agree that peritoneal drainage is not warranted for simple acute appendicitis, and that drainage of a localized collection of pus from a ruptured appendicitis, *ie.*, an appendiceal abscess, is beneficial.[8,1,4,11,12]

Yates,[19] in 1905, compiled an extensive historical, clinical and experimental review which strongly argued that "drainage of the peritoneal cavity was physically and physiologically impossible," and that "peritoneal drainage must be local," . . . and that "there was, aside from hemostasis, no other justification for the use of drains." A majority of surgeons avoid drains in adults with generalized peritonitis.[13] There is a general feeling that it is physically impossible to drain the entire peritoneal cavity, and that placement of a drain in these circumstances may be harmful because it is a foreign body which is rapidly walled off and may enhance the formation of adhesions around the drain and subsequently lead to intestinal obstruction. Other surgeons feel that a peritoneal drain may also act as a nidus for infection.[2]

In the belief that children, particularly infants, handle generalized peritonitis poorly, authors of many textbooks of children's surgery have espoused transperitoneal drainage for ruptured appendicitis with generalized peritonitis.[5,9,14] Several series in children have reported that "drains are probably of some value";[10,17] that "when there is gross evidence of perforation, a drain in the lateral gutter out of the wound is favored",[10] or that "drainage was used in all cases of ruptured appendix."[7]

Since decisions regarding transperitoneal drainage have, in the past, been based largely upon retrospective studies or personal experience and observation, the present prospective, double blind study was formulated. With no difference in basic management, except for a warranted change in antibiotic coverage, all children with ruptured appendicitis and generalized peritonitis were randomly selected for either transperitoneal or superficial wound drainage.

Analysis of the data from this study of 43 children, 24 of whom had transperitoneal drainage and 19 wound drainage, does not demonstrate any benefit from transperitoneal drainage. The incidence of intraperitoneal abscess formation, necessity for re-operation, and mortality, were unaffected by the mode of drainage. There was, however, no increase in morbidity associated with the use of transperitoneal drainage.

Conclusions

On the basis of data obtained in a 6-year prospective double blind study of transperitoneal drainage versus non-drainage for generalized peritonitis from ruptured appendicitis in children, transperitoneal drainage did not decrease morbidity or mortality from this condition. The mortality (2/43) occurred in the transperitoneal drainage group, but this may simply represent statistical chance in a small group of patients. It does emphasize the continuing mortality of approximately 5% from ruptured appendicitis. It is our feeling that specific intensive antibiotic therapy and good, general supportive treatment provide maximally effective treatment for children with generalized peritonitis, and that transperitoneal drainage does not contribute significantly. For this reason, we have abandoned transperitoneal drainage in the management of this condition in children.

Acknowledgment

We appreciate the cooperation of our pediatric and surgical residents in the accumulation of data for this study—in particular, Drs. James Talbert, John Cahill, William Morgan, George Peters, Howard Wexler, and Patricia Moynihan.

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Discussion

Dr. Richard Miller (Jackson): Recently, we had the opportunity to review some 370 children with appendicitis at the University of Mississippi Medical Center. Dr. Haller presented an important subject in the high incidence of complicated appendicitis which occurs in children.

[Slide] In our series it was 33%. The incidence of perforation about doubles in the presence of a fecalith, and is also higher in the very young. It is, therefore, well to know whether drainage has any effect.

After seeing Dr. Haller's abstract, we again went over our computer sheets in regard to those children undergoing appendectomy, with or without drainage. Our series is not prospective, and is, therefore, biased. Probably the sickest patients were drained, but it is somewhat unbiased as to the surgical thinking, as it represents the work of many surgeons—mainly residents, however—over 10 years.

[Slide] I hope you can read these. I have just penciled them in at the last minute here. This slide illustrates a comparison of the lengths of hospitalization in the various groups. There was very little difference in the patients with simple appendicitis with appendectomy. They were all hospitalized about 4 days. As opposed to Dr. Haller's patients, whose hospital stay was from 14 to 17 days, ours for simple appendicitis were: just appendectomy, 4 days; appendectomy and drainage, 4.4 days; appendectomy in the perforated ones, without drainage, 4.3 days. These are complicated as interpreted by reading the op. note. If the op. note said the appendix was perforated, we put it in this category.

In the appendectomy and drainage category there were 81 patients, and the hospital stay was 8.5 days.

[Slide] Culture data also produced a higher number of positive cultures in the drain group—positive meaning positive cultures. There were many more positive cultures in this group than in the group that just underwent appendectomy. It may be, however, that there were definitely more nonreported cultures, the negative here—"n. g." mean no growth—in the patients who had just plain appendectomy, versus those who had appendectomy and drainage, and it may be that our house staff was not as vigorous in culturing this group as they were in this group, [indicating] which they thought were sicker.

[Slide] The incidence of postoperative complications of perforated appendicitis with appendectomy only was minimal. There were only two serious problems in 29 patients with perforated appendicitis, no drainage; four wound infections. There was one peritonitis—postop peritoneal infection—which did not require operation, and one postoperative peritoneal infection which did require a secondary drainage procedure.

[Slide] However, in the 81 patients with appendectomy and drainage there were relatively more complications. There were 15 wound infections. There were seven cases of either intraperitoneal infection or obstruction which required secondary operation, and there were six cases of either obstruction or intraperitoneal infection which required prolonged hospitalization.

We are indebted to Dr. Haller for trying to make some sense out of this in a prospective study, and we are certainly going to go on with it. I am sure he has not changed any of our biases regarding this, and we will all continue on.

I would like to ask Dr. Haller whether or not his culture data in the two groups were similar. In other words, were there the same number of positive cultures from the peritoneum in the drained and the nondrained group?

Dr. Richard J. Field, Jr. (Centreville): We were intrigued by Dr. Haller's fine contribution in helping us to sort out the problems involved in drainage of appendicitis, and we reviewed our own cases over the last several years. There were 300, with 20 perforated appendicitis, with generalized peritonitis. It was our policy, reflecting Dr. Ochsner's feelings, not to drain these people. We did not.

Of the 20 with perforated appendicitis and generalized peritonitis, three developed other intra-abdominal abscesses, two in the *cul de sac*, one on the left side of the abdomen. We drained the two *cul de sacs*, following the stimulation of Dr. Harlan Stone, of this organization—transrectally, without any difficulty. The other was drained through the peritoneum.

The rest of the patients did fine in our series. We, too, concur with Dr. Haller that drainage of the peritoneal cavity, regardless of age, is not necessary. With good antibiotic therapy and good intravenous replacement of fluid, these people should and did respond well.

Dr. Alton Ochsner (New Orleans): In the early '20's, during my training in Chicago, it was the custom to drain every abdomen that had any pus in it. Later, after I went to Europe, as an exchange surgical resident in Zurich, under Clairmont, I was astounded and shocked to see many individuals with ruptured appendices—who were treated by closing the abdomen tightly after the appendectomy. I expected all of them to die. This was before the advent of antibiotics. Much to my astonishment, they lived, but they developed more complications, because they lived to develop the complications. They developed more subphrenic abscesses, *cul de sac* abscesses, and abscess in the ileocecal region.

It is important to differentiate between children and adults, as Alex has already alluded to. The children have a smaller peritoneal cavity. The omentum is less well developed, and their *cul de sac* is really not a *cul de sac;* it is a saucer. It is not a cup—it is a saucer—and for this reason when the child is placed in a Trendelenberg position, the peritoneal fluid cannot gravitate into the *cul de sac,* as in the adult, but the peritoneal fluid rises up on the left side, and these infants, or children, are more likely to develop a left-sided abscess.

I am convinced that drains in generalized peritonitis can do nothing but harm. They will produce more complications, and I am sure the mortality rate will be greater; but the complication rate may be a little higher, because they live long enough to develop the residual abscesses, which can be drained.

Dr. Julian K. Quattlebaum, Sr. (Savannah), discussing Paper No. 12: Those of you who join me in an experience of 50 years can look back on those days and recall, with little effort, some of the sickest children that ever breathed, and some did not breathe very long, at that.

Those were the days when anesthesia was drop ether, and often utterly inadequate. Parenteral fluids were limited to home-made saline solution; antibiotics and sulfonamides were undreamed of. Blood transfusions were thought of as being next to impossible. Doctors in those days seldom had more desperate cases than children suffering from suppurative peritonitis from a ruptured appendix, often complicated by necrotizing infection of the abdominal wall and not infrequently by small bowel obstruction also.

I mention this because the mortality rate was so very high and because no discussion of this subject before the Southern Surgical Association should fail to mention the monumental contributions