Effect of Fluid and Antibiotic Administration on Experimental Fecal Peritonitis*

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In a previous report, rapid development of hypovolemia, severe metabolic acidosis and bacteremia of gram-negative bacilli were demonstrated in dogs with experimental fecal peritonitis. Therefore, the effect of fluid administration was examined. In gastric juice peritonitis, the experimental animals recovered from shock only after fluid administration even in the late stage. In the fecal peritonitis, however, fluid therapy was far less effective. Although intravenous instillation of a large amount of fluid, which was started immediately after intraperitoneal injection of fecal material, maintained systemic blood pressure at normal level for a considerable period and prolonged the survival time, it was not effective in preventing elevation of hematocrit and severe metabolic acidosis. On the other hand, rapid administration of a large amount of fluid in cases of already advanced fecal peritonitis showed only transient improvement of systemic blood pressure and could not improve metabolic acidosis, nor caused it any significant prolongation of survival of the animals. The effect of intraperitoneal administration of antibiotics was evaluated in the fecal peritonitis. Even large doses of antibiotics could not prolong the survival time of experimental animals when an extremely large amount of fecal material had been injected intraperitoneally. The treatment was effective only when intraperitoneal contamination was not so severe.

The studies concerning the mechanism of shock in peritonitis have raised a number of questions of clinical importance,1–9 and the complexity of the problem and the limited effect of the present therapy against severe intraperitoneal infection are well known in general.

In a previous report of ours,10 we experimentally demonstrated a prominent fluid shift, marked metabolic acidosis, severe bacteremia in dogs with fecal peritonitis in comparison with those with gastric juice or bile peritonitis. However, marked hypovolemia alone was not sufficient to account for the rapid development of shock in fecal peritonitis. In the first part of the present study the effect of fluid therapy on the course of experimental fecal peritonitis was examined, and in the second part the effect of antibiotics was evaluated.

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**Materials and Methods**

Evaluation of fluid therapy was studied in dogs in the same way as described in the previous report. Studies on the effectiveness of antibiotics were done using mice and dogs which had received intraperitoneal injection of fecal suspension.

**Results**

**Effect of fluid administration**

1) *Gastric juice peritonitis (Fig. 1)*

Aseptic gastric juice, 5 ml/kg of body weight, was injected into the peritoneal cavity of 6 dogs. Subsequently, four injections of 3 ml/kg of body weight of the same gastric juice were performed every 3 hours. Fluid therapy was started 24 hours after the first injection of gastric juice. At this time systolic blood pressure was less than 100 mmHg, arterial blood pH 7.25 and the circulating plasma volume about 70%. Fluid therapy consisted of an intravenous injection of the mixture of two parts of isotonic saline, two parts of 5% glucose and one part of dog's plasma. The rate of intravenous injection was 30 ml/kg/hr in the first 30 minutes and 5 ml/kg/hr thereafter. The blood pressure began to rise immediately after fluid therapy was instituted, blood pH was improved within a few hours and all dogs survived (Fig. 1).

*Fig. 1. The dogs were injected with aseptic gastric juice in 5 ml/kg intraperitoneally and followed by 4 successive injection of the aseptic gastric juice, 3 ml/kg every 3 hours.*
2) Fecal peritonitis

Group I: In four dogs, intraperitoneal injection of 10% fecal suspension, 5 ml/kg of body weight, was immediately followed by intravenous administration of the same mixture of fluid as mentioned above. The mixture was administered at the rate shown in Fig. 2.

Group II: In two dogs, fluid therapy was started 4 or 9 hours after the injection of fecal suspension before any definite sign of shock appeared. The mixture was injected at the rate shown in Figs. 5 and 6.

In group I, hematocrit progressively rose despite administration of a large amount of fluid. However, the larger the amount of fluid, the less the elevation of hematocrit (Fig. 2). The development of metabolic acidosis was hardly prevented (Fig. 4). Although blood pressure was maintained for about 12 hours, it fell rapidly thereafter (Fig. 3). The fluid administration seemed to have some effect in prolonging the survival time, but not a single dog ultimately survived the disease. Autopsy revealed that the administration of fluid had brought about a remarkable accumulation of ascites.

In group II (Figs. 5 and 6), blood pressure was elevated soon after fluid therapy was started. The effect of fluid therapy, however, was only temporary and blood pressure began to fall within half an hour and it progressively dropped to the shock level in spite of continued fluid therapy. Significant prolongation of

![Graph showing effect of fluid infusion on hematocrit and plasma protein in dogs with experimental fecal peritonitis. The number on the right side of curves shows ml/kg of body weight/hr of the fluid given.]

Fig. 2. Effect of fluid infusion on hematocrit and plasma protein in dogs with experimental fecal peritonitis. The number on the right side of curves shows ml/kg of body weight/hr of the fluid given.
survival time was not achieved by fluid therapy. A transient improvement of blood pH was observed, but no effect on base excess.

Even an intensive fluid therapy seemed to be ineffective in advanced fecal peritonitis.

Effect of antibiotic administration on fecal peritonitis in mice

Inbred strain dd-mice, 5 to 6 weeks old and weighing 23 to 25 g, were used. Antibiotics were chosen as listed in Fig. 7, their safety for intraperitoneal route being taken into consideration. Each antibiotic was diluted in sterile saline so as to yield the dosage listed in Fig. 7 in 1 ml. Intraperitoneal administration of antibiotics was started immediately after injection of fecal suspension and repeated every four hours until death.

Group A: 0.3 ml of 10% fecal suspension was injected into the peritoneal cavity of mice. All mice that received this dosage and no antibiotics survived not longer than 9 hours. As shown in Fig. 7, antibiotic administration significantly prolonged the survival time of mice. Colimycin, a broad spectrum antibiotic, or combination of two antibiotics was much more effective than penicillin or erythromycin alone. This result was in accordance with the fact that the fecal suspension used in this experiment contained mostly gram-negative bacilli such as *Escherichia coli*. 

![Effect of fluid infusion on blood pressure in dogs with experimental fecal peritonitis.](image)
Experimental Fecal Peritonitis

Fig. 4. Effect of fluid infusion on blood pH and base excess in dogs with experimental fecal peritonitis. The amount of the fluid given was indicated in figures, in ml/kg body weight/hr.

Group B: 0.9 ml of 20% fecal suspension was injected into the peritoneal cavity of mice. This dosage was 6 times larger than in group A. All mice took a rapid fatal course and died in 6 to 11 hours. No significant prolongation of the survival time was observed in spite of intensive chemotherapy.

Effect of Kanamycin on fecal peritonitis in dogs

In these experiments a dose of 0.1 g/kg of Kanamycin was given intraperitoneally immediately after the introduction of fecal suspension. The treatment was repeated every six hours until death.

In five dogs which received intraperitoneal injection of 10 ml/kg of 10% fecal suspension, administration of Kanamycin was hardly effective. All dogs died in 6 to 9 hours without significant prolongation of survival time. On the other hand, 2 ml of the same fecal suspension were injected into five dogs by the same route. This inoculum had been previously proved to be enough to kill dogs within 16 hours. All dogs treated with Kanamycin were alive for 26 to 48 hours, and significant prolongation of the survival time was achieved.
Fig. 5. Effect of fluid infusion on blood pressure and blood pH in dogs with experimental fecal peritonitis.

Fig. 6. Effect of fluid infusion on blood pressure and blood pH in dogs with experimental fecal peritonitis.
**DISCUSSION**

Peritonitis due to chemical irritation is seen in the early stage of stomach perforation, bile peritonitis or some type of pancreatitis. In this type of peritonitis, fluid administration is the first choice in the treatment and always very effective in improving shock.\textsuperscript{2,11} The circulatory insufficiency observed in dogs which had received repeated injections of aseptic gastric juice into the abdominal cavity seemed to be caused mainly by a simple hypovolemia, because fluid administration alone was sufficient to ensure a prompt recovery from shock and to save the experimental animals.

There is no doubt about that fluid shift is more rapid in fecal peritonitis and this is presumably the most basic factor causing early onset of shock. However, in peritonitis associated with severe intraperitoneal infection, especially in fecal peritonitis due to perforation of the colon, a more serious and complicated mechanism must be superimposed.\textsuperscript{12-17} Experiments in group I (Fig. 2) disclosed that the elevation of hematocrit was not effectively prevented by massive fluid administration starting immediately after the onset of fecal peritonitis. At autopsy, accumulation of profuse ascites was detected according to the volume of fluid given. These results seemed to indicate a marked increase in the permeability of peripheral blood vessels. Intensive fluid therapy which was started immediately after the fecal introduction temporarily maintained the systemic blood pressure and extracellular fluid, but a major portion of the injected fluid seemed to leak out of the intravascular space. The progress of metabolic acidosis was not prevented by fluid therapy. In the advanced stage of fecal peritonitis, even a rapid administration of a large amount of fluid could not prevent the deterioration of the general condition and had no effect in significantly prolonging survival time. The result can be interpreted by assuming that the factor of metabolic derangement in such a
stage of peritonitis so predominant and severe that the condition cannot be controlled by fluid therapy. The metabolic acidosis in fecal peritonitis is possibly not only due to tissue anoxia by peripheral circulatory failure but also due to specific metabolic disorder in severe inflammatory process or bacterial toxin. The mechanism of this disorder is not yet clarified. It seemed, however, that the severity of fecal peritonitis is closely related to bacterial invasion into the bloodstream. Although we failed to demonstrate endotoxin-like substance in the circulatory blood of the animal with severe fecal peritonitis, this negative result does not rule out the role of bacteremia in the early development of shock in fecal peritonitis. It was suggested that endotoxin shock could occur as an anaphylactic phenomenon.

Intensive antibiotic administration was ineffective in fecal peritonitis with extreme contamination, while it brought about a significant prolongation of the survival time in cases with mild contamination. In cases with massive contamination, it is not reasonable to consider that the number of bacteria may be enough to cause bacteremic shock without their proliferation. However, we did not clarify whether the difference of effectiveness of antibiotics depends solely upon the bacteria or other fecal substances which have some synergetic activity. It is obvious that the experimental results suggest an important role of bacterial factor in the early development of shock in fecal peritonitis. From the experimental results mentioned above, one should keep it in mind that the mechanism of shock in fecal peritonitis is much different from that in gastric juice or bile peritonitis. When massive contamination such as fecal leakage is suspected, we should not lose time with preoperative fluid administration or others in expectation of complete recovery from shock, because fluid administration improves only temporarily the systemic blood pressure. Even during fluid therapy, metabolic derangements and peripheral circulatory failure progress rapidly. In such cases, operative treatment should be done as early as possible. Operative removal of contamination source is essential even if the shock condition is not satisfactorily improved.

References


