Treatment of paralytic ileus A consideration of the rationale of each therapeutic procedure

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"TREATMENT OF PARALYTIC ILEUS"

A CONSIDERATION OF THE RATIONALE
OF EACH THERAPEUTIC PROCEDURE

SENIOR THESIS

1933

ROLAND F. HUBNER
Ileus, as we generally think of it, is an intestinal colic due to obstruction which is accompanied by tympanitic and croup-like pains usually recurring periodically with nausea and vomiting, in which the latter becomes fecal in character.

Two types of ileus:

1. Mechanical due to adhesions constricting bands or volvulus.
2. Paralytic or adynamic in which the cause may be bacterial or non-bacterial. Or expressing this type by still another nomenclature one may say that it is peritonitic or traumatic in character and that it brings about infiltration of intestinal wall by:
   a. leucocytes, serum and other products of inflammation.
   b. the effects of extra intestinal or intra intestinal toxins on the motor nerves.
   c. traumatism to the intestines, peritoneum, and abdominal nerves.

In ileus occurring post-operatively, however, one is occasionally confronted with a simple mass dilatation of the intestine. This condition is one of the most distressing features with which the surgeon is called upon to treat. And the dilatation of the bowel of course, exaggerates the paresis.
The bacterial type presents a wholly different aspect than that of the non-bacterial type, inasmuch as in the former, there is early in the case, a hyperperistalsis. The picture of the condition is a typical one and not easily forgotten. The abdomen is markedly distended. There are acute recurring attacks of severe colicky pain accompanied by nausea and vomiting. The patient's expression is a peculiar one in which the eyes are bright. The cheeks are flushed and there is a look of anxiety stamped on the patient's face. The mouth is dry. The tongue is parched and brown. The patient complains of thirst, though he may be unable to retain liquids taken by mouth. The pulse is rapid, but full. And any attempt to bring about a bowel movement or even to obtain the passage of flatus will be of no avail. The temperature has begun to ascend and there is extreme restlessness, as is evidenced in cases of peritonitis.

Patients suffering from the non-bacterial type of paralytic ileus do not, in many instances, complain of severe or recurrent attacks of pain. And even though the abdomen is sharply distended, one does not hear the gurgling due to hyperperistalsis. Nausea and vomiting are present and are almost constant. Therefore, liquids are not retained. Thirst asserts itself. No bowel movement occurs. The pulse becomes quickened and the individual is rapidly dehydrated, although the temperature is scarcely increased until toxic products have begun to be absorbed and made themselves manifest, in which case the patient is nearing the exodus lethalis, even without realizing that he is a
sick person.

Death is probably brought about by:

1. Inability of the patient to take and retain a sufficient amount of nourishment.

2. Absorption of toxic products from bacterial accumulation.

3. Poisonous effects of acid products of the G. I. tract given rise to.

4. Fatigue of the nervous system.

In order to thoroughly understand the subject at hand it is absolutely essential that we know something of the innervation and mechanics of the intestinal tract, especially the small intestine. And since this paper deals directly with paralysis of the intestinal movements and how to remedy this state of affairs, it is a natural process that we first consider the movements of small intestine of the so-called normal individual or that person who is enjoying average good health.
The muscles of the small and large intestine are arranged in two layers, an outer longitudinal and inner circular layer, while between these coats and in the submucous coat there are present the nerve plexuses of Auerbach and Meissner.

Physiologists have been studying the movements of the small intestine both by direct observation and by means of the barium meal and X-ray examination. The sum of the evidence at this time seems to indicate that there are three types of movements: (1) rhythmic segmentation, (2) pendular movements, (3) peristaltic rushes.

Rhythmic Segmentation

These are the most constant and fundamental types of movements. They are essentially rhythmic contractions of the circular muscles; the constriction appearing at those points at which masses of food lie. The contractions knead the intestinal contents, mix them with the digestive juices, and spread the contents again and again over the absorbing surface of the mucous membrane. Cannon describes the process thus:

"A mass of food is seen lying quietly in one of the loops. Suddenly constrictions at regular intervals along its length cut it into little ovoid pieces. A moment later each of these segments is divided into two particles, and immediately after the division, neighboring particles rush together and merge to form new segments. The next moment these are divided, and neighboring particles unite to make a third series, and so on."
Some physiologists are of the opinion that these rhythmical contractions of the circular coats may also act as a pumping mechanism upon the venous plexuses in the walls and thus aid in driving the blood into the portal system.

These contractions occur with considerable regularity at a frequency which varies inversely with their distance from the stomach, and is of the order of twelve a minute in the ileum. The different frequencies at different levels is due, according to Alvarez, to the existence of a 'metabolic gradient' from above downwards - the upper portion having a higher rate of metabolism and being more excitable than the lower parts.

Pendular Movements

These are less conspicuous and appear as side-to-side swaying movements which cause a local mixing of the intestinal contents with the digestive juices similar to that produced by the segmenting contractions. They are probably a consequence of a to-and-from movement of intestinal contents resulting from intermittent contractions in different parts of the loops.

Peristaltic Rushes

These waves cause onward progress of the contents of the intestines. Arising in any part of the small bowel they may run either short or long distances. They usually move slowly, at the beginning about 2-4 cm. per second, but since they travel faster the further they go, by the time they reach the ileum they are often covering 7 to 25 cm. per second.
Some physiologists describe it as a wave involving contraction of the gut above the food mass and relaxation below it. Bayliss and Starling contend that stimulation of any portion of the gut causes contraction above the point stimulated and relaxation below it (the myenteric reflex). The same effect is produced by the introduction of a bolus of food, especially if this is bulky or irritating. Alvarez does not hold with these authors, but after a thorough study of the subject has come to the following conclusions. The direction of the metabolic gradient of the intestine, the peristaltic rush involves the co-operation of the local nervous system, i.e. Auerbach plexus. He believes the peristaltic wave, according to Bayliss and Starling, is abnormal; and in his opinion true peristalsis consists of a series of rushes usually traversing the length of the small intestine, traveling at a more rapid rate, and in which the constriction is less intense and not preceded by a wave of relaxation.

Quoting from Alvarez's book, "The Mechanics of the Digestive Tract": "If I were asked to formulate a law for the intestine, I would say that stimulation at any point leads to the holding back of material coming down from above, and the hurrying on of material already below. Such a law would fit in much better with the facts observed not only in the laboratory but also in the clinic."

As a result of the intestinal movements described above, the food is thoroughly mixed with the digestive juices, and the products of digestion are brought into contact with the intestinal wall and absorbed. The residue is passed on by occasional peristaltic contractions through the lower ileum and thence into the colon.
We have just considered one of the factors upon which normal intestinal function depends i.e. the types of movements. The other factor is the nerve supply to the intestine. This is an intricate mechanism or network of nerve fibers which controls the movements already discussed. And since it is the controlling factor it is obvious that a thorough understanding of its formation and function is necessary.
If one wished to make a thorough study of the literature dealing with the nerve supply to the intestine he would be impressed with the fact that much of it is composed of opposing theories and contradictory laboratory results. The best we can hope to do is to review the work of the reliable man working in this field.

It has been appreciated from the early beginning of physiology that the intestinal tract is a complex mechanism capable of normal motor activity in the absence of all extrinsic nerve control. The nerves of the small intestines are derived from the plexuses of sympathetic nerves around the superior mesenteric artery. From this source they run to Auerbach's plexus of nerves and ganglia situated between the circular and longitudinal muscular fibers from which the nervous branches are distributed to the muscular coats of the intestine. From this a secondary plexus, Meissener's plexus, is derived; and is formed by branches which have perforated the circular muscle fibers. This plexus lies in the submucous coat of the intestine; it also contains ganglia from which nerve fibers pass to the muscularis mucosae and mucous membrane. Baylis and Starling and other physiologists have demonstrated on numerous occasions that peristalsis begins, in the isolated intestinal loop, in the plexuses of Meissener and Auerbach. There is also some evidence that the rhythmic or pendular activity of the intestine is also dependent on the activity of the intrinsic nerve supply to the intestine. Many of the definite statements of authors, who favor the neurogenic theory of the cause of
intestinal contraction, are based upon the work of Magnus. Although even he had to admit that the movements could be myogenic in origin.

Still other physiologists state that if the mucosa and submucosa be removed from the loops of intestine the automaticity of the activity of this loop is not disturbed. Since the plexus of Meissener is in the submucosa, it is to be presumed that this plexus has nothing to do with the activity of the small intestine. However, this same group of men contend that separation of the circular from the longitudinal muscle fibers of the small intestine destroys the automatic activity of the circular fibers but not that of the longitudinal fibers.

Gunn and Underhill; Alvarez and Mahoney are not in agreement with either of the preceding views of the intrinsic nerve regulation of the small intestine. In contradiction to the experiments of other physiologists they found that the circular muscular layer, when deprived of its associated nerve net continued to show the function of automatic rhythmicity. Since in the late years the majority of workers are beginning to agree with Alvarez, it would seem clear that rhythmic contraction must be a property of muscle tissue and the probability is that it is brought about simply as a result of recurring cycles of chemical activity. That being so, it would appear that the rhythmic movement has a myogenic origin until otherwise proven. When pulsations die down or cease when a tissue is bathed in a neurotropic poison, we must suspect that their origin is essentially a nervous one; but when they really increase in frequency and amplitude, as in this case, the myogenic origin seems most logical.
In addition to the intrinsic there is also an extrinsic nervous mechanism for the small intestine. This is purely a regulatory nerve supply and is derived partly from the vagi and partly from the splanchnic nerves.

The sympathetic system, of which the splanchnics are a part, arise in the central nervous system. According to Gaskell's conception the afferent fibers enter the spinal cord with the posterior or sensory nerves after passing through the posterior root ganglions. From the posterior root ganglions, fibers pass into the cord through the posterior roots and end in the lateral horn. From the lateral horn cells efferent fibers, which are medullated (white rami communicantes) pass out through the anterior horn. The white rami communicantes end in the sympathetic ganglions located on each side of the vertebral column. From these ganglions non-medullated fibers or gray rami communicantes pass to the various viscera.

The vagus nerve contains somatic sensory, sympathetic afferent, somatic motor and sympathetic efferent fibers. Of these we are interested only in the sympathetic efferent fibers. These fibers arise from cells in the dorsal nucleus. They are preganglionic fibers of the sympathetic system and all terminate in sympathetic ganglia from which postganglionic fibers are distributed to the various viscera, including the small intestine.

Baylis and Starling and others have presented evidence to prove that the primary action of the vagus is motor, while the action of the splanchnic nerves is essentially antagonistic and performs the function of inhibition. They have also shown that stimulation of the vagus produces a preliminary inhibition, but it is a known fact that the
stimulation of any sensory nerve produces an initial inhibition of intestinal movement. Since the vagi contain a certain number of sensory fibers preliminary inhibition, as a result of stimulation of these nerves, is to be expected.

The splanchnics are inhibitory as evidenced by the fact that division, either chemical or mechanical, of the splanchnics produces a marked increase in intestinal movements; conversely stimulation of the splanchnics produces a cessation of such movements. In certain cases paralytic ileus, the extreme relaxation of the intestinal musculature is probably the result of increased inhibition reaching the intestinal musculature by way of splanchnics.

In the treatment of any functional disorder of the human body one must first consider the normal physiological function of the part involved. The small intestine has several functions but we are primarily concerned only with the movements. This we have already discussed. The purpose of the remainder of this paper is to consider therapeutic measures for restoring normal movement to the paralyzed intestine.

In recent years, especially in Europe, considerable work has been done both experimentally and clinically, on the use of hypertonic salt solution in the treatment of adynamic ileus. I find many references in the literature regarding the method of the effect of hypertonic saline solutions. These may be summarized to the effect that the infusions have a double action. The hypertonic salt solution causes, in a direct manner, a strong contraction of the smooth musculature and on the other
hand it evokes a strong efflux of tissue fluids into the blood, and thereby makes possible the elimination of a number of toxic substances from the body which had accumulated in the tissues. The detoxicating action of the hypertonic saline solutions is regarded, by many, as still more important than the stimulating effect upon the peristalsis.

Haden and Orr in their series of articles and studies referable to the toxic substance just mentioned, have concluded that in the presence of an unknown toxic substance elaborated as a result of the obstruction, the NaCl radical in the blood is broken up, the sodium ion combining with CO\(_2\) to circulate as sodium carbonate, and the chlorine ion is either lost or fixed in some way by the toxic products of the obstruction.

In support of their conclusions they report their experimental studies on the chemical changes in the blood of man after intestinal obstruction. The majority of their experimental study was performed on dogs, but the changes were confirmed by work on man.

Summary of their conclusions:

Dogs which were afflicted with untreated pyloric or duodenal obstruction died, on an average, in four days. They all showed a fall in the chlorides of the blood usually with a coincident rise of the CO\(_2\) combining power of the blood plasma followed by a marked rise in the non protein nitrogen. In the urine of these dogs was found a high level of non protein nitrogen and an almost total absence of chlorides.

Clinically we find that the blood changes in man afflicted with intestinal obstruction, are comparable to those observed ex-
perimentally in the dog. These clinical changes are due to the action of some toxic body which is absorbed in the blood stream subsequent to intestinal obstruction, the nature of which is not known. The rise in the non protein nitrogen of the blood, in the absence of any kidney disease, is an indication of the extent of protein destruction taking place as a result of the toxemia. The fall in chlorides suggests that the chlorides are being used as a protective agent against the toxic body. The alkalosis is probably an incident in the chloride metabolism in which the sodium ion is released due to the utilization of the chloride ion with carbonic acid to form sodium bi-carbonate.

If this assumption be correct that the chlorides in intestinal obstruction are a protective agent against the toxic body, the administration of sodium chloride is indicated in this condition. Haden & Orr report a patient to whom 90 grams of sodium chloride was given subcutaneously during the first 36 hours after admission, with but 1.8 grams appearing in the urine and without a rise above normal in the blood. This seems to show that the body tissues have utilized the supply of chloride and indicates its need in such a condition.

The value of sodium chloride as a therapeutic measure was also proven experimentally by several other workers. Dogs with intestinal obstruction treated with 50 c.c. of 10% NaCl solution daily did not develop the characteristic blood changes. Other dogs with obstruction for 48 hours, showing typical blood changes and treated with 50 c.c. of 10% NaCl daily, showed a rapid return of the blood to normal. Dogs treated with 25% glucose or plain water developed
the changes as rapidly as those which were not treated.

These conclusions are substantiated by many clinical men including the group at Mayo Clinic and McVicar. Coleman, too, used this type of therapy in a series of cases with very good results. The toxic changes in the blood were markedly reduced and in some cases disappeared entirely with complete recovery of the patient. This series compared with a similar series of cases in which hypertonic saline solution was not used. On the latter, results were not favorable. The results in these two series of cases proved conclusively the therapeutic value of hypertonic saline solution in minimizing the effect of toxic substances, following intestinal obstruction, upon body activity.

There is still another action of NaCl upon the intestine which has a marked therapeutic value in adynamic ileus. This is the stimulating effect of hypertonic salt solution upon smooth muscle tissue. In 1924 Hughson and Scarff, in a series of experiments, demonstrated the effect of intravenous injection of 30% NaCl upon loops of intestine distended at a constant pressure. As a result of their work they assumed that as an activator of intestinal peristalsis, sodium chloride intravenously is effective under practically all experimental conditions, except when the blood supply to the bowel has been cut off. This would indicate that the effect of the NaCl was directly on the muscle fibers of the intestinal wall, causing contraction by a withdrawal of the fluid from the muscle cell.
The intestine of the experimental animal was treated in a variety of ways, in an attempt to simulate the different types of ileus encountered clinically. The use of NaCl solutions injected intravenously furnished a distinctly reliable agent for promoting peristalsis in intestinal loops which for some reason had lost their normal motor activity. This action of salt should always be born in mind when it is used to replace the NaCl lost from the bloodstream. Postoperative distension, a mild form of ileus, which frequently responds so poorly to treatment, might very well be avoided by the use of NaCl solution. The above authors also report two cases of adynamic ileus treated successfully with NaCl when other methods failed.

Other experimental and clinical evidence, revealed by Orr[32], proved conclusively that the administration of hypertonic NaCl solution will stimulate both the intestinal tone and peristalsis. He performed a series of experiments in which artificial intestinal obstruction was produced. In almost every experiment a hypertonic solution of NaCl injected intravenously produced an increase in gut tone and stimulated peristalsis of the jejunum. With the physiologic solution or glucose no definite change could be noted.

The consensus of opinion, at the present time, seems to be that NaCl solution can be given intravenously with perfect impunity in concentration of from 15 to 30%. In doses of from 2-2.5 grams per kilo of body weight the salt becomes toxic, so that administration of 1/6 to 1/3 of a gram per kilo of body weight gives a distinct margin of safety and this dose should be used. In those patients with impending
paralytic ileus 500 c.c. of 5% NaCl solution should be given intra-
venously as an initial dose if the blood chlorides are much below
normal. It is important to give this solution very slowly. It is
a practical rule to follow that 20 c.c. of 10% solution should be
given over a period of five minutes and 500 c.c. of a 5% solution
must consume at least an hour. At this rate the effect upon the
arterial and venous pressure will be negligible. If one does not
practice extreme care in this procedure a local thrombosis will at
times form in the vein rendering it unfit for future use.

(26) Kuesenhoff has used infusions of hypertonic saline solution
for intestinal paresis in a number of cases. He states the results
were always good and occasionally astonishing. He first employed it
in the cases of intestinal paresis which developed in the post
operative course following laparatomies.

He proceeded as follows: The operated patient, as customary,
is treated with heat and the simultaneous introduction of an
intestinal tube, when no gases have escaped after twenty-four hours.
In the mild cases the impaired intestinal function is thereby stim-
ulated. A simple enema in the form of a glycerine clyster then pro-
duces the evacuation of the contents. When the intestine after thirty-
six hours has not resumed its function, in spite of these measures,
10-20 c.c. of 10% NaCl solution is injected intavenously. In the mild
cases an elimination of gas is obtained in a very short time after
the injection. When the desired effect remains absent, the patient
receives a rectal infusion of a 20% saline infusion in a quantity of about 125-150 c.c. This is best given in the form of a glycerine clyster or a drip enema. Following this the elimination of gas is usually observed within the first thirty minutes. In the very severe cases of intestinal paresis the intravenous and rectal infusion is combined at the onset. Even the rectal infusion alone which was carried out on patients, who were not suitable for intravenous administration, frequently led to successful results.

In the milder cases a further influence upon the reawakened intestinal peristalsis was not necessary. In the severe manifestations of ileus several infusions were necessary. These infusions can even be given several times a day without harm to the patient. Following the rectal infusions, especially when repeated several times, mild evacuation of mucous from the rectum may occur. This however soon disappears. In the experience of Kussenhoff no other remedies had to be employed for the combating of intestinal paresis.

(26) Case No. I. A woman, forty-six years old, who on admission presented a complete severe paralytic ileus. Of the history it is mentioned that the patient suffered from a chronic obstipation and had suffered from gastric colics allegedly six weeks prior to admission to the clinic. Five days prior to admission she became acutely ill during the night with severe chills. On the following day she suffered from a severe feeling of illness and pains around the waist. Her temperature rose to 102.6 degrees. Stools were only attained by means of purgatives. The urine examined by her family physician contained leucocytes and epithelial cells. On the second day following the initial chills, severe abdominal pains and complete retention of gases and stools set
in. The abdomen was distended. The patient vomited. Enemas were unsuccessful, The abdomen remained distended and exceedingly painful, especially the epigastrium. Micturation was possible but connected with a burning sensation.

The condition of the patient became progressively more alarming, so that the attending physician referred her to the clinic on account of ileus. The woman was in a very poor condition with distinct facies abdominalis, high fever, and a dry, coated tongue. Pulse accelerated. The abdomen was very much distended and painful to pressure. Tenderness in the left renal region. Intestinal sounds were not perceivable. The urine contained leucocytes. Immediately following admission the patient was given 15 c.c. of a 10% saline solution intravenously as well as a rectal infusion. Within the first hour considerable gas and fecal matter were eliminated. The alarming abdominal symptoms disappeared and the intestine became functionally normal. The urological examination made a few days later revealed a mild pyelitis of the left side, which was regarded as the cause of the severe ileus, since later examination of the gastro-intestinal tract showed no other reason therefore. The prompt results of the therapeutic measures showed that an accompanying ileus was involved, the pyelitis being the cause.

According to what has been stated, hypertonic saline solution, in the treatment of adynamic ileus, has proven itself very efficient both in the laboratory and in the hospital. It has the great advantage,
when employed correctly, of almost always producing results free from sequelae. And, in addition, this method of procedure is both simple and economical.

Since Wagner in 1922 published his first paper on the treatment of ileus with spinal anesthesia the literature has been replete with cases treated by this method. Although previous to this time the observation had been frequently made that the intestines were found in a state of contraction and incontinence of faeces occurred following spinal anesthesia; it remained for Wagner to emphasize the therapeutic value of this procedure in the treatment of paralytic ileus.

In recent years Oschner and his co-workers have experimented with a similar method of therapy which is known as splanchnic analgesia. Since the two methods of treatment are similar, both in procedure and effect, they will be discussed jointly in this paper.

The most natural question in discussing a new treatment is to ask, "What is the rationale of this procedure?" In the case of the question at hand it depends upon the conception of an antagonistic dual innervation of the intestine by Vagus and Splanchnic nerve fibers. Both spinal and splanchnic anesthetics are directed to the abolition of the inhibitory influence exerted by the sympathetic system upon the intestinal musculature. Experimental evidence indicates that a condition of reflex tonus exists by reason of the action of the sympathetic nerves supplying the intestine and the effect of this tonus normally is the prevention of excess peristalsis. The fact that section of the splanchnics produces a marked increase in intestinal movements is
adduced as evidence in support of the idea; again stimulation of the splanchnics produces a reduction or cessation of these movements. Marked and continued stimulation would bring about a condition of relaxation of the intestinal musculature of varying degree as a direct result of the inhibitory action of the sympathetic fibers. Therefore any method which would accomplish the interruption of such inhibitory influences should cause a renewal of peristalsis, or strengthen its force if already present, provided the intestinal musculature is still capable of contraction.

(34) The establishment of spinal anaesthesia does accomplish such a section of the white rami communicantes as they leave the spinal cord. Splanchnic analgesia interrupts the fibers of the splanchnic nerves at the point at which they break up into the splanchnic plexuses anterior to the bodies of the first and second lumbar vertebrae. Nicotine splanchnic analgesia interrupts the synapses which occur in the semi lunar ganglion, i.e. the connection between the pre and post ganglionic fibers of the splanchnic nerves. Spinal anaesthesia should be as effective as splanchnic analgesia if all the fibers entering into the formation of the splanchnic nerves, or at least the reflex involved in the splanchnic control of the intestine, are blocked. That spinal anaesthesia is actually not as efficient as splanchnic analgesia in experimentally produced ileus seems to indicate that a good part of the reflex involved in inhibitory regulation of the intestinal movement occurs by way of a reflex arc which does not traverse the spinal cord.
Theoretically, any therapeutic measure aimed at restitution of motor activity to a paralyzed intestine might take at its point of departure, (1) the muscle cell itself, (2) the intrinsic nervous system of the intestine, (3) the extrinsic nerve supply. Considering only the extrinsic nerve supply, any attack against the vagi must of necessity involve stimulation; whereas a similar attack directed against the splanchnics must involve paralysis.

 Interruption of impulses traveling along the splanchnic nerve may conveniently be performed in two places by chemical means: the first, at the point where the white rami communicantes leave the spinal cord by way of the ventral or motor root; the second, in the retro peritoneal space in the region of the first lumbar vertebrae where the nerves enter into the formation of the semi lunar ganglion and the greater, lesser and least splanchnic plexuses. Chemical section of the roots entering into the formation of the splanchnic nerves is not difficult, since it merely involves the introduction of an anaesthetic solution sufficiently high in the sub-arachnoid space to anesthetize the segments of the cord from the fifth dorsal to the first lumbar vertebrae. The technique of such a procedure, according to Studdiford, is as follows.

 The patient is placed in the lateral position, and the back prepared with iodine and draped. A needle was passed through a skin wheal of 2% novacaine between the second and third lumbar vertebrae into the spinal canal. About 6 to 7 c.c. of spinal fluid was withdrawn and in it dissolved 0.10 gram novacaine. The resulting
solution was injected into the spinal canal. The attempt was made to obtain an anaesthesia to the angle of the scapula as the splanchnics are said to receive branches from as high as the fifth to the sixth dorsal segments. This was usually successful. After this the patient is placed flat on her back.

Actually the performance of this procedure is not without danger not only from the point of view of infection, but also from the point of view of intra dural hematoma formation and mechanical injury to the cord; which occurs only in those cases in which puncture is made at a higher level than the termination of the cord.

Splanchnic analgesia although technically somewhat of a more formidable procedure than that of spinal anaesthesia, is relatively void of danger when carefully performed.

Of the three general methods which have been devised for the production of splanchnic analgesia, the Wendlung technic, which involves puncture of the intact abdominal wall, probably has no place in rational surgical intervention. The Brown technic involves preliminary laparatomy and somewhat extensive intra-abdominal manipulation, and is, therefore practically never indicated in ileus. (37) Oschner and his co-workers strongly advise the use of the method of Kappis, which involves the introduction of a needle posteriorly through the flank. The injection is made at four different points; one on either side of the middle approximately opposite the first lumbar vertebrae, and one on either side below and at corresponding points opposite the second lumbar vertebrae. The solution which he
recommended was a plain two per cent solution of procaine hydrochloride in physiological NaCl solution. Twenty cc. of this solution should be injected at each of the four points. Ephedrine should not be used if the desired effect is on the intestinal movement.

Another drug, which is used at times in splanchnic anaesthesia is nicotine. This exerts no effect on the nerve trunk itself, but paralyzes the sympathetic junction in the semi lunar ganglion. (37) Oehnner et al ran various series of experiments with animals and on clinical studies with patients using both nicotine and procaine hydrochloride in splanchnic analgesia. They comment thus on their results:

"We believe that the use of nicotine in the treatment for intestinal obstruction is contra indicated not only because it is inefficient in increasing intestinal movements but because of its undesirable blood pressure raising characteristics. Amounts of nicotine sufficient to produce even noticeable splanchnic effects are capable of doubling the blood pressure. In the use of procaine hydrochloride one avoids the undesirable effect of raise in blood pressure."

So far in our consideration of spinal and splanchnic anaesthesia as a method of treatment for adynamic ileus we have attacked the subject only from the viewpoint of technic and rationale of this type of therapy. At this time a consideration of the observation of some of the men, who have had considerable experience in this field, both clinically and experimentally, would probably be in order.

Markowitz and Campbell were among the first men to investigate the effect of spinal anaesthesia upon the paralyzed intestine. At
this time their work is recognized as one of the most complete and thorough experimental studies on this subject. They investigated the effect of spinal anaesthesia on the following conditions in dogs:

1. Intestinal paresis observed at laparotomy
2. Ileus by injecting iodine intra peritoneally
3. Ileus by intra abdominal manipulation as rubbing parietal and visceral peritoneum with gauze.

Their results show that spinal anaesthesia in the dog abolishes the inhibition of bowel movements brought about by laparotomy, or by the intra peritoneal injection of iodine, or by traumatizing the bowel or peritoneum. These observations make it seem very probable that paralytic ileus is essentially reflex in nature and that chemical changes which have been described in the blood are the result and not the cause of ileus.

Assuming the results as obtained in the dog hold good also for man, paralytic ileus as met with in the clinic must be in nature of a reflex inhibition, depending therefore on the integrity of the reflex arc. Such a conception implies that paralysis at laparotomy is a physiological ileus and if unrelieved or augmented by other irritant stimuli merges into paralytic ileus.

The French are among the more enthusiastic advocates for the clinical use of spinal anaesthesia in adynamic ileus. P. Duval stated, in a report before the Societe Nationale de Chirurgie that in his experience in no case of obstruction did spinal anaesthesia fail to produce a rapid, copious and satisfactory evacuation from the bowel. He urges that it is the most satisfactory treatment for the intestinal obstruction, no matter from what course, and that it should take
precedence over any other procedure.

Duval has collected the reports of 400 cases and tabulated the results as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Cases</th>
<th>Successful</th>
<th>%</th>
</tr>
</thead>
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<tr>
<td>Strangulated hernia</td>
<td>257</td>
<td>27</td>
<td>10</td>
</tr>
<tr>
<td>Adynamic ileus</td>
<td>44</td>
<td>30</td>
<td>68</td>
</tr>
<tr>
<td>Mechanical ileus</td>
<td>99</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

He provides further data concerning adynamic ileus, with which this paper is chiefly concerned.

<table>
<thead>
<tr>
<th>Type</th>
<th>Cases</th>
<th>Successful</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spasmotic</td>
<td>8</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>Postoperative</td>
<td>11</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td>Ileus without cause</td>
<td>2</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Ileus in peritonitis</td>
<td>18</td>
<td>10</td>
<td>55</td>
</tr>
<tr>
<td>Pure reflex ileus</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Twisted ovarian cyst</td>
<td>4</td>
<td>1</td>
<td>25</td>
</tr>
</tbody>
</table>

From these statistics he draws certain conclusions:

(1) Spinal anaesthesia is contra indicated in acute ileus should the patient be exhausted, toxic or collapsed.

(2) Spinal anaesthesia is not preferable to local in strangulated hernia.

(3) Spinal anaesthesia is the method of choice in post operative ileus in which it is very frequently successful. He believes coliotomy
should follow satisfactory evacuation of bowels by spinal anaesthesia.

(4) Spinal makes the following operation easier.

David and Loring do not agree with the experience of the French workers as to the merits of spinal anaesthesia in stimulating the paralyzed bowel. They point out the fact that in most cases of paralytic ileus, as seen in general peritonitis, the patient is extremely toxic, the blood pressure is low and the cardiovascular system at low ebb. To induce lumbar anaesthesia with consequent paralysis of the lower extremities, as well as to still further lower blood pressure, or in some instances to interfere with respiration, is a somewhat heroic procedure. With these facts in mind experimental work was done to determine the efficiency of splanchnic anaesthesia.

While it must be appreciated that these experiments on dogs can not be unreservedly applied to the human they nevertheless serve that purpose to a large measure. The results showed a reestablishment of intestinal peristalsis, after the removal of the inhibitory effect of the splanchnic nerves by splanchnic analgesia, in local peritonitis and early stage of general peritonitis; but in severe and existent peritonitis little or no aid in the reestablishing of intestinal movement is to be expected.

Gässner, Gage and Cutting performed a similar set of experiments and found that, ten to thirty minutes after the introduction of the chemical irritant into the peritoneal cavity, splanchnic anaesthesia will produce a characteristic picture of active intestinal movements. They conclude that cases of ileus resulting from inhibitory
impulses being supplied the intestinal musculature by way of the splanchnic system should be classed as cases of paralytic or adynamic ileus. In these cases blocking of the sympathetic nervous system by splanchnic analgesia is of distinct value.

Chemical section of the splanchnic nerves, either by subarachnoid block or by infiltration of the retro peritoneal space in the region of the splanchnic nerves, as a therapeutic measure, is open to criticism because of the fall of blood pressure it produces. Depression of the blood pressure is more marked in spinal analgesia than in splanchnic analgesia and for this reason spinal is less desirable. A decrease in blood pressure is undesirable for usually patients suffering from ileus have a low blood pressure initially.

Considering the effect of spinal and splanchnic analgesia on motor activity evidence seems to show conclusively that splanchnic analgesia is preferable. The reason why it is most efficient is not apparent since both involve a chemical section of the splanchnic nerves. But the most logical reason is that not all the pathways of the reflex arc involved in the inhibitory control of tone and intestinal movements pass through the anesthetized part of the cord, but part of the mechanism may involve transmission of impulses through the sympathetic plexuses extra-durally. In this case the effect of direct infiltration of the ganglia and plexuses formed by the splanchnic nerves would produce a complete block, while spinal anesthesia would not.

Throughout the preceding pages we have considered spinal and splanchnic analgesia from the point of view of rationale of treatment.
and method of procedure. From the experimental and clinical results of a large group of men we must naturally conclude that the procedure is an efficient one. We cannot say that it is the best method, but it has proven itself as efficacious as any method so far devised for the treatment of paralytic ileus.

Case No. 2

Mr. M. H. White, age 56 was hospitalized at 4:30 P.M. on November 9, 1929 on account of acute retention of urine of three days duration, overflow incontinence unless catheterized, and coincident complete constipation which stupes, purges and enemas had not relieved. He had three vomiting attacks within the past twenty four hours and felt nauseated constantly. His general history was negative except for nocturia, urgency and strangury, which began a year and a half ago and gradually increased in severity until November 6th, when his present symptoms started.

Examination revealed a large obese male lying quietly in bed; head negative but for dry, red, furred tongue and decidedly carious teeth; neck negative, lunge without rales or dullness, respiration 30; heart regular and without murmurs, pulse 98, blood pressure 150/95. The abdomen was acutely distended, without visible peristalsis or rigidity or tenderness on palpation. Its percussion note was tympanic and auscultation revealed absolute silence. The bladder extended about one half way to the umbilicus and catheterization released nearly a quart of urine. Rectal examination digitally disclosed a firm
bilateral prostatic hypertrophy. Extremities and nervous system was negative.

An enema at 5:15 p.m. was ejected as fast as it was injected. A hypodermic of surgical pituitrin, m.XV, was administered at 5:15 p.m. and repeated at 5:45 without avail. A diagnosis was made of paralytic ileus, reflex, from acute urinary retention.

By 10:00 p.m. his condition was unimproved. There appeared no reason for change in diagnosis and no reason for delaying further therapeutic measures. At 10:30 p.m. the patient was removed to the operating room where 2 cc. of spinocaine were injected intradurally at the second lumbar interspace. He was then laid supine and the table adjusted to a five degree Trendelenburg position. Within twelve minutes anaesthesia to the costal margin ensued and active peristaltic sounds could be auscultated. Thereupon his legs were elevated into Bierhoff stirrups, the anal sphincter was dilated digitally, and the abdomen massaged along the course of the colon for perhaps sixty seconds before involuntary stool began to be evacuated.

Thereafter he was left untouched and in the next half hour passed over a quart of liquid excrement. He was returned to bed at 11:30 p.m. and a retention catheter was fixed in the urethra. At 2:00 a.m. another copious evacuation occurred involuntarily. His course later was uneventful and he was discharged from the hospital November 12th 1929.
The treatment of paralytic ileus has always been unsatisfactory, which can easily be demonstrated by the multiplicity of therapeutic measures. After all other methods have been tried on the case of paralytic ileus the physician, in despair, turns to the operative procedure in a last desperate attempt to give relief to his suffering patient, and if it does not prove successful he condemns the procedure as having no therapeutic indications.

Enterostomy is probably the most common method of operative procedure performed for the relief of ileus. There is still a general controversy over the merits of the operation, but in the experience of Bartlett it has proved a most valuable resource. On the other hand Southam claims that in cases in which the bowel is paralyzed, enterostomy only drains the affected loop and is therefore of limited value. In his opinion all attempts to stimulate the bowel should be avoided. The most effective method is to give the bowel a chance to rest and a chance to recover its power of active contraction. This treatment combined with enterostomy, above the effected portion of the bowel, does undoubtedly prove successful in many cases.

Anyone who has been reading the literature dealing with the treatment of adynamic ileus is impressed with the high mortality reported following enterostomy. This is undoubtedly the concomitant of its use in already dying patients.

It has been natural to delay interference until sufficient
Time has elapsed for the patient's condition to make operation imperative. This is the crux of the situation, for when we take as our criterion a condition that is no longer only potentially dangerous, the sequel of enterostomy is apt to be death from many factors too long existent before operation even though action of the bowel be established. Clearly, then a new criterion for interference becomes necessary. Bartlett believes that he has such a criterion. He believes that in the response of the paralytic gut to spinal anaesthesia we have a true indication for or against enterostomy.

If, within fifteen minutes, after the injection of the spinal anaesthetic, passage of gas and faeces and disappearance of distension be not obtained, enterostomy should be performed immediately thus taking advantage of the anaesthesia already produced. After failure of response to spinal anaesthesia expectant treatment alone, no matter how fortified by attempts to meet the patient's physiological needs, only delays the inevitable.

We have then, in spinal anaesthesia, a therapeutic test which gives the indication that enterostomy will become necessary before the condition of the patient makes it evident.

In acute intestinal obstruction, whether mechanical or paralytic in origin, the fatal condition resides in the distended bowel, its contractile force inhibited, its contents intensively septic and thrown back constantly into the more healthy bowel, its
nerve and other structures traumatized by distension and a transudative peritoneal irritation developing. The greatest urge is to meet these conditions rather than to relieve the obstruction. In these cases Brinkley objects strenuously to a wide exploratory incision and further manipulation of an already traumatized bowel. He is convinced that the least done to relieve the acute symptoms is the keynote to success in the treatment of paralytic ileus.

Southam is even more conservative in handling this type of case. His impression is that during the first forty-eight hours ileus is rarely complete, and the intestine will frequently recover its function if given a reasonable chance. In this type of case all nourishment by mouth must be stopped so as to avoid further overloading of an already distended bowel. Fluids should be given freely by the rectal and subcutaneous route. Where vomiting is troublesome gastric lavage is valuable, and can be repeated as often as necessary. Morphine in doses of gr. 1/6 gives relief from pain, and in spite of apparent contra indications will be found useful.

If improvement does not follow this method in forty-eight hours, operation is necessary. The following is Southam's procedure:

A local anaesthetic of two per cent novacaine is used. A left paramedian or rectus splitting incision is made just above the umbilicus, and the first distended loop which presents is drawn into the wound. This is clamped after it has been emptied and a large
catheter is sutured into the bowel by Witzel's method. According to this method the tube is laid three or four inches along the bowel and the serous and muscular coats sutured over it. The tube is then brought out through a gap in the omentum and the wound closed around it. This enterostomy of the valvular type will close when the tube is removed without necessitating a second operation.

This is the easiest and safest procedure to follow when the patient is in a poor condition. After the intestine has emptied itself through the tube the lumen of the bowel is usually restored and the contents begin to pass normally. The tube can then be removed and the fistula will close spontaneously.

Hunt likewise believes that surgery should not be delayed beyond the point of the certainty of the failure of non-surgical methods. But he gives the impression that caecostomy is preferable since maximal dilation is usually in the caecum and ascending colon. The caecum is readily accessible through a split muscle incision which allows the introduction of a large catheter or drainage tube, by which the intestinal tract is deflated and emptied of toxic material. Caecostomy possesses an additional advantage over ileostomy or jejunostomy in that the intestinal contents from the caecum do not digest the structure of the abdominal wall. The incision heals spontaneously.

Anyone interested in the treatment of patients with acute ileus must have been encouraged with the enthusiastic recommendations that have been given enterostomy as a life saving procedure. Within the last fifteen years a good many noted surgeons have recommended the
procedure.

Van Beuren and Smith have compiled statistics in an effort to prove the value of enterostomy. They say, "We had hoped to be able to show that enterostomy is an effective treatment, we are still inclined to believe that it is, but we find ourselves trying to explain why statistics do not show it."

Following are two of the charts compiled by Van Beuren and Smith:

**Comparison of entire enterostomy and non-enterostomy group.**

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</thead>
<tbody>
<tr>
<td>Entire enterostomy group</td>
<td>58</td>
<td>12</td>
<td>46</td>
<td>79.2</td>
</tr>
<tr>
<td>Entire non-enterostomy group</td>
<td>82</td>
<td>44</td>
<td>38</td>
<td>46.3</td>
</tr>
</tbody>
</table>

Comparison mortality of enterostomy late groups, and non-enterostomy late groups - forty-eight hours after onset.

<table>
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<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterostomy group</td>
<td>30</td>
<td>12</td>
<td>18</td>
<td>60</td>
</tr>
<tr>
<td>Non-enterostomy group</td>
<td>23</td>
<td>12</td>
<td>11</td>
<td>47.8</td>
</tr>
</tbody>
</table>

The mortality of the enterostomy group is decidedly higher. The poor choice of cases and the additional shock of operative procedure may account for this fact. Since enterostomy has frequently been performed without proper appreciation of its limitations, an undeserved appearance of danger has been given to the procedure.

Enterostomy is not a sure cure nor is there any magic about it. Like other surgical procedures it must be performed in the right way and at the right time to be effective. In cases in which the patient
has acute ileus in an advanced stage, the condition is primarily chemical, and purely mechanical treatment cannot be effective.

In the future surgeons treating cases of paralytic ileus, by this method, must keep this fact uppermost in their mind if they wish to be more successful than their colleagues of the past. From the review of some of the opinions of men using this therapeutic procedure it seems imperative that operation be performed early with as little manipulation as possible.

It is a matter of common knowledge that drugs, as a rule, are of relatively little value in combating the well established and graver forms of disease processes. It would seem in order therefore, to emphasize the fundamental importance of the early recognition and early treatment for any abnormal process in which reliance is to be placed on drug therapy. In the following discussion of the usefulness of drugs in the treatment of paralytic ileus, all clinical and experimental evidence is considered solely in its relationship to the case that has been recognized early. It should hardly be necessary to remark that the relief of ileus is not synonymous with the treatment of ileus since treatment involves complete restitution of normal function and the combating of any abnormal associated processes. In this article we are concerned solely with a consideration of the use of drugs frequently considered beneficial in the stimulation of intestinal motility, drugs which presumably may be of value in restoring normal motility to a paralyzed intestine.

The first drug to be considered is pituitary extract. This method of therapy is probably the oldest procedure used to relieve
paralytic ileus, It is still being administered at the present, but experimental and clinical evidence has demonstrated that it is not as efficacious as was previously thought.

**Pituitary extract stimulates directly smooth muscle tissue.** Justification for calling upon the smooth muscle, in a time of dire need, for a greater output of energy is in the fact that it is probably less exhausted than the neural tissue. King used pituitary extract routinely in treating intestinal paresis. He concluded that the stimulation of smooth muscle tissue by 1 cc. of pituitary extract injected rapidly is tremendous; while if three or four minutes be consumed in administering the same quantity, the stimulation will be more moderate. He states that this drug administered intravenously will empty the intestines, both large and small, promptly and thoroughly in by far the large majority of uncomplicated cases of intestinal paresis.

Some of the more recent investigators do not agree with the conclusions of King drawn some eighteen years ago. In a series of experiments performed by Oschner, Gage, and Cutting the effect of the intravenous or intra muscular injection of 1 cc. of pituitary extract was observed in twenty-four different dogs.

Their conclusions were that on blood pressure the drug had three separate effects.

1. a transitory increase, moderate in degree.
2. a subsequent depression to below normal.
3. an increase to above the former level and maintained.
The characteristic effect of the drug on the small intestine was one of decrease of tone and inhibition of peristaltic movements (75 percent of the cases). There were some exceptions to this but the increase in tone was not marked. Thus it seems that according to the more recent investigations pituitary extract would not only seem to be an inefficient drug in the treatment of intestinal atony but it is dangerous due to its characteristic of increasing blood pressure. The occasional beneficial effect is far outweighed by the depressant effect of the drug.

Physostigmine is another of the drugs which has been used for years in the treatment of intestinal atony. Its continued use suggests that it may have a place in the therapeusis of this condition.

There are many references in the literature to the use of physostigmine for the relief of abdominal distension, but they were based on theoretical considerations rather than on clinical experience. It was not until Martin & Weise undertook their investigation that we gained clinical knowledge of the action of physostigmine. They divided their cases into two groups.

(1). Non toxic group (16 in number) in which abdominal distension followed laparotomy, surgical shock, early intestinal obstruction or injury to the nervous system.

(2). Toxic group (15 in number) in which the condition was associated with peritonitis or general toxemia.

In the non toxic group the injection of the proper dose of physostigmine resulted in the patient belching or expelling gas from the rectum. Defecation accompanied by a moderate colic may occur. Moderate perspiration occurs almost invariably, and profuse sweating is not infrequently observed. The pulse rate is usually increased and there is commonly a
a rise in blood pressure equivalent to 10 to 20 mm. of mercury. During the progress of these signs the previously distended abdomen becomes soft and this change is accompanied by a marked improvement in the patient's general condition. (29)

Martin and Weiss were of the opinion that the dose of physostigmine, being used at that time, was insufficient. They found that the effective dose of the salicylate or genzoate was 3 to 4 mg. injected intramuscularly. Such a dose may be repeated once after the hour if it produces no systemic effects, and it may be repeated three times at intervals if there is no evidence which indicates that its systemic effects persist. The general condition of the patient and his behavior toward the drug must be observed carefully and must serve as a guide for the repetition of the dose.

The results seem to be in line with those obtained by the more careful and unprejudiced investigators. Although many observers have reported evidence to the contrary, at the present time physostigmine seems to have a definite therapeutic indication in the relief of paralytic ileus; but there is a marked disagreement on the action of pituitary extract. Thus we leave the subject in a more or less unsettled state of affairs.

There is still another drug which has been used recently to stimulate contraction of a paralyzed intestine. This is choline, a substance which is normally present in the muscular layer of the stomach and intestines. In 1912 Weiland, while engaged in an investigation of the rhythmic movements of the small intestine, made the chance observation that when a
piece of isolated intestine was allowed to contract in Ringer's solution for some time the fluid acquired the property of exciting contraction in other pieces of intestine placed in it. The substance that stimulated this contraction was later indentified by LeHoux as choline.

Choline is present in the extract of the supra renals in large amounts, also in the extract of the brain and sympathetic ganglia; although neither food nor the supra renals appear to be the source of the base. The intestine endeavors to retain its store of choline, and it is found here even in such conditions as prolonged chloroform narcosis or peritonitis.

In experiments performed by Magnus it was shown that paralysis of the bowel, produced in cats by long continued chloroform narcosis, was speedily relieved by the intra venous injection of 5-15 mg. of choline hydro chloride per kilo gram of body weight.

Arai brough about peritonitis in cats by the intraperitoneal injection of iodine. The paralysis was overcome by the injection of choline. The production of a typical operative ileus, simulating that seen in man, was produced by exposing the intestine to air with manipulation. In such cases no evacuation of faeces took place in thirty hours unless choline was administered. When this was done a normal stool followed in a short time.

In 1925 Klee and Grossman reported encouraging results from the administration of choline to 120 cases of paralytic ileus. Their method of administration was as follows. Sterile choline hydro-chloride is put up in glass ampules containing 600 mg. in 6 cc. This is diluted with 180 cc. of sterile normal saline and the resulting solution injected intra venously.
An important point in the administration is that it should take at least 17 min. to inject the whole quantity.

From the case reports in the literature it would seem that choline intra venously has a definite place in the therapeusis of intestinal stasis due to paralysis of the normal movements. Its physiological principles are sound and from its clinical results its use seems advisable.

In 1927 Williams published a new theory as to the cause of paralytic ileus. Since the toxemia of paralytic ileus and gas gangrene bear a striking resemblance, he was of the opinion that these two conditions may have a definite relationship. In order to prove this he set about to examine the intestinal contents of cases of acute paralytic obstruction for abnormal proliferation of toxin producing anaerobes.

But the presence of B. Welchii or other anaerobes did not imply that toxin formation took place. Therefore in order to demonstrate the presence of the toxin he took the filtrate of the intestinal contents of a series of cases and injected it into mice protected by B. Welchii anti toxin and mice which were unprotected.

<table>
<thead>
<tr>
<th>Source of int. contents</th>
<th>Duration</th>
<th>Unprotected Mice</th>
<th>Protected Mice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tot.  Died</td>
<td>Tot.  Died</td>
</tr>
<tr>
<td>Peritonitis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Case</td>
<td>7 days</td>
<td>10 5</td>
<td>5 0</td>
</tr>
<tr>
<td>Dog No. 1</td>
<td>83 hours</td>
<td>4 4</td>
<td>2 0</td>
</tr>
<tr>
<td>Dog No. 2</td>
<td>65 hours</td>
<td>6 6</td>
<td>2 0</td>
</tr>
<tr>
<td>&quot; 3</td>
<td>72 hours</td>
<td>6 4</td>
<td>4 0</td>
</tr>
<tr>
<td>Obstruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human No. 1</td>
<td>3 days</td>
<td>12 2</td>
<td>6 0</td>
</tr>
<tr>
<td>&quot; 2</td>
<td>4 days</td>
<td>10 2</td>
<td>10 0</td>
</tr>
<tr>
<td>Dog &quot; 1</td>
<td>56 hours</td>
<td>8 7</td>
<td>4 0</td>
</tr>
<tr>
<td>&quot; 2</td>
<td>51 hours</td>
<td>8 0</td>
<td>4 0</td>
</tr>
</tbody>
</table>
The results seem to indicate definitely that the toxin is present, although the
definite amount cannot be determined.

In view of the results obtained by Williams and some of his co-workers, he suggests that B. Welch anti toxin should be given to all cases of peritonitis which show signs of intestinal paralysis and toxemia. The effect is to neutralize the toxin after its absorption from the intestine. It is important, therefore, to realize for what length of time one should continue to administer the serum. An adequate supply of anti toxin must be continued until the small bowel is emptying itself regularly and effectively. By this means a patient may be given time to overcome his peritonitis.

In the therapeutic use of anti toxin it is essential that large doses be employed. The initial dose of serum should be at least 80 cc. into muscularly. In extreme cases as additional 40 cc. can be given intravenously. After this 40-80 cc. should be given intra muscularly daily until the bowel evacuates itself spontaneously and effectively.

The experiments indicate the presence of a true bacterial toxin, intestinal in origin and probably a product of B. Welch. The administration of anti toxin, to the experimental animal and to the patient in the clinic suffering from paralytic ileus due to peritonitis, has demonstrated admirable results in the hands of several able workers. This data has not been able to produce absolute proof of the hypothesis, as a whole, due to the nature of the problem and the technical difficulties. Suffice it to say that in the hands of Williams the procedure has proven itself to be a valuable therapeutic aid.
Conclusions

(1) The use of hypertonic saline solution and spinal anaesthesia are the most widely accepted therapeutic measures at the present time. Reports of considerable experimental and clinical investigations have been published in the literature and results seem to indicate that the measures have proven of definite aid.

(2) If results are to be expected from operative interference, the operation should be done early and not only on cases in which other therapeutic measures have failed.

(3) Use of drugs and B. welchii anti toxin is not generally accepted, although their advocates claim that they have a specific therapeutic value.

(4) A great deal of experimental and clinical work has been done, both in Europe and in this country, in an attempt to find some specific treatment for the condition, but from the foregoing pages it would seem that the question of treatment of paralytic ileus is still an open question.
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