IMMUNITY IN INTESTINAL OBSTRUCTION.

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During the past few years a large amount of experimental work has been done in order to solve the problem of the cause of death in intestinal obstruction. This work has added to the knowledge of the physiology of the intestinal tract, but the cause of death from intestinal obstruction still remains unknown. It is generally conceded that a systemic bacterial invasion by the organisms of the obstructed intestine does not occur, and most of the clinical and experimental evidence so far obtained points to a quickly developing and rapidly fatal toxemia. The nature of the toxin is disputed, and investigations on this point thus far reported are not conclusive. The most extensive studies in this field have been made by Whipple, Stone, and Bernheim (1, 2, 3, 4), who ascribe the symptoms to a toxic primary proteose formed by the perverted activity of the intestinal mucosa. Leaving aside the question of how it is formed, we wished to determine, if possible, whether the toxic factor is really a primary proteose. A method of attack was suggested by the work done by Whipple, Stone, and Bernheim (3) in attempting to produce an immunity to the obstruction toxin. If an immunity to the toxin can be demonstrated it will show that the toxic factor in all probability belongs to that group of substances which have antigenic properties, namely the proteins, and their primary product of hydrolysis, the proteoses. The claim that a relation exists between antibody formation and non-proteins is apparently erroneous.

The conclusions of Whipple, Stone, and Bernheim,[1] as a result of their studies on immunity in intestinal obstruction, are not, in our opinion, warranted by the observations they have reported. Un-

[1] Whipple, Stone, and Bernheim (3), p. 164.

less extremely marked, immunity to a disease or toxin is always difficult to determine. In regard to the presence or absence of immunity in intestinal obstruction, we had noticed that dogs showed an extreme variability in their resistance to intestinal obstruction produced in various ways, and we believe that this normal variation recognized by Whipple and others accounts for most of their results.

The methods of Whipple, Stone, and Bernheim in localizing the immunity of a so called immunized dog should be noted. They obtained serum from a dog immunized by sublethal doses, added a lethal amount of duodenal fluid obtained from a closed duodenal loop, chloroform, and toluene, and incubated the mixture for 20 hours at 38°C. It was then tested, filtered, and injected in dogs. The injection caused death, and hence they concluded that there was no antiferment in the serum. Their further study was as follows:

"Many of the immune organs were washed free from blood and ground to a paste which was combined with a lethal dose of the duodenal loop fluid, diluted with water to a thin paste, and allowed to autolyze at 38°C. for 2 to 5 days with chloroform and toluol. The filtrate was then tested on normal dogs by intravenous injection. The spleen and lung emulsion destroyed the poison. The liver juice (Buchner press), diluted and filtered, also destroyed it rapidly. The intestinal mucosa destroyed some of the poison but a part remained even after 5 days' digestion. A fresh mixture of liver juice and loop poison gave fatal intoxication, showing that the reaction is not prompt or does not take place in the blood stream. This result serves as a control. If the protective action resides in a single type of cell, it is the endothelial cell that may be concerned, but it is of course possible that various body cells may develop the reaction or produce the ferment."

Can we conclude that an immunity reaction is the cause of the loss of toxicity by a fluid of complicated composition allowed to autolyze 5 days under toluene and chloroform with organ extracts? It may be true that the liver and spleen would contain more antibody or a higher concentration, were there any formed, than the blood serum, but there would certainly be some liberated into the blood, and it is not probable that the intestinal mucosa and lung would contain large amounts of a neutralizing substance and the blood none. The fact that "fresh mixture of liver juice and loop poison gave fatal intoxication, showing that the reaction is not prompt or does not take place in the blood stream" would indicate that the reaction is not that between an antigen and an antibody. The statements that they discovered no neutralizing principle in the serum of immunized dogs and that they observed nothing of an ana-

phylactic reaction in guinea pigs detract from the evidence that the fluid has antigenic properties.

Davis and Morgan (5) were not able to confirm the results of Whipple and others, using autolysates of normal cat organs and cat serum with the fluid from dog closed loops, since they found that cats were apparently more highly resistant or immune to the intoxication of intestinal obstruction than dogs.

Nesbitt (6) endeavored to show that neurine may be split off from the choline in lecithin and is present in the intestinal canal during obstruction. He also noticed a ptomaine (unidentified) as a constituent of the material above an obstruction. Barger and Dale (7) demonstrated the presence of the depressor substance β-iminazolylethylamine in the intestinal mucosa. Mellanby and Twort (8) corroborated this and isolated a bacillus which they claimed could convert histidine into this substance. Murphy and Brooks (9) observed:

"5. The toxicity of the loop content is not destroyed by heating to 60°C. until sterile, or even by boiling.

6. The toxicity of the fluid is very much decreased by filtration through a Berkefeld filter, so that to produce death a dose of filtrate corresponding to several times the lethal dose of unfiltered fluid is necessary.

7. The amount of filterable toxin is increased by prolonged autolysis."

Draper (10) was unable to find a proteose in the 1,000 cc. of loop fluid which he analyzed. These results all indicate that the toxic factor is not of a protein nature.

Methods.

As the symptoms caused by a closed intestinal loop, whether produced by ligature and a reconstruction of the gastrointestinal tract by gastroenterostomy, or by resection of the loop and an end to end anastomosis of the intestine, parallel closely the symptoms of acute intestinal obstruction, we have used the following control procedures: (1) the production of open intestinal loops, (2) the antemortem removal of closed intestinal loops, (3) the production of a blind duodenal stump, (4) ligature of the duodenum with no anastomosis, (5) injection of the material from closed intestinal loops.

Dogs were used in all the experiments. All operations were done under complete surgical anesthesia (morphine-ether) with the usual aseptic technique.

1. Production of Open Intestinal Loops.—As shown by Dragstedt, Moorhead, and Burcky (11), a certain proportion of dogs, in their work 50 per cent, can survive an open unwashed loop of the duo-

denum which is permitted to drain into the peritoneal cavity. This has been confirmed by the writers in a large number of dogs, and open loops have been made of the duodenum, jejunum, and ileum. While the number of dogs operated on in the lower part of the small intestine is not large, the work indicates that the lower the loop is, the smaller is the percentage of animals surviving an open unwashed intestinal loop—in approximate proportion to the increased number of bacteria found. The open loops upon later examination are in about half the instances found open and draining, while in the rest they are tightly closed by omental adhesions and are usually found fairly distended with a thick yellowish white material, which is often not sterile. Where the loops have been found open and draining a marked edematous and hemorrhagic appearance of the omentum and serous surfaces of the viscera is noticed, and three dogs died about 3 weeks after the operation from omental hemorrhage.

Whipple and his associates (4) produced an open loop of a different sort. The duodenum just below the pancreatic duct was cut across and ligated with inversion of ends and closure. A gastroenterostomy was done just below the duodenojejunal flexure so that a loop of the duodenum was produced which could drain into the jejunum. They state:

"The presence of such a partially isolated duodenal loop may be associated with intoxication, more or less severe, which will bring about an immunity reaction in the body cells. The intestinal mucosa from such a dog has the characteristic property of immune tissue; it can destroy with some rapidity the duodenal loop fluid *in vitro* and render the mixture harmless when given intravenously to a normal dog."

If there is a specific toxic secretion in a loop of such a nature that it can act as an antigen upon absorption, it is logical to conclude that the constant absorption of this substance would render dogs surviving open intestinal loops highly immune to the toxins of intestinal obstruction. All our methods of testing resistance to intestinal obstruction were tried out on these dogs, with the result given in Tables I, II, and X.

2. Antemortem Removal of Closed Intestinal Loops.—To answer the objection that an open intestinal loop is not an obstructed loop and hence the conditions necessary for the secretion of a hypothetical toxic proteose do not prevail, resected and closed unwashed loops of the beginning jejunum were produced in dogs and removed before the

loop had perforated, but as long after the production of the loop as the condition of the animal would warrant. The majority of the loops were markedly distended, already cyanotic in color, and contained approximately 80 to 110 cc. of bloody fluid. Although the period of immunization is necessarily short, it is to be expected that animals almost moribund from acute intestinal obstruction would, upon recovery, show a marked immunity if it can be produced. Here, too, there is tissue destruction, with resultant absorption of protein split products, and the chance of an increased absorption of the hypothetical toxic proteose. Hartwell, Hoguet, and Beekman (12) say that the toxemia is in proportion to the tissue necrosis, and without the latter there are no toxic symptoms. About half the dogs whose loops were removed before perforation died, indicating that there had been a marked absorption of toxic material by the time of the operation. Removal of the loop is a short and simple procedure. It was tried as an immunizing method in three series of dogs (Tables VI, IX, and X).

3. Production of a Blind Duodenal Stump.—Early in the work the authors noted that dogs in which a drained loop of the duodenum was made and the reconstruction of the canal effected by gastroenterostomy were not in as good condition as dogs in which end to end anastomosis was made. This was noted by Sweet, Peet, and Hendrix (13), and Whipple, Cooke, and Stearns (14) later operated to produce a blind duodenal stump as a method of causing a chronic type of obstruction in dogs. Most of the dogs in their series died in from 1 to 3 weeks with symptoms similar to those of obstruction. According to Whipple, these dogs have a definite tolerance to proteose injections. In conjunction with some other work the authors made a number of blind duodenal stumps, making the gastroenterostomy at the greater curvature and as near the pylorus as practicable, varying the length of the blind stump from about 8 to 50 cm.

If this type of operation results in a chronic obstruction and the toxin thereof is identical with the toxin of acute obstruction, this will be a better procedure to test out the immunity of a dog than the production of a closed loop as there is no perforation peritonitis to obscure results.

4. Ligature of the Duodenum with No Anastomosis.—In view of the

fact that the average length of life for closed loop dogs was higher in Whipple's series than in ours, a comparison of methods was necessary. The difference is easily explained. The closed loops as made by Whipple were produced by double ligature of the duodenum, just below the lower pancreatic duct and again at the duodenojejunal junction, reconstructing the tract by gastroenterostomy. This, of course, results in a longer loop than is possible by the method of resection and an intestinal anastomosis. The mechanical feature of this will, of course, explain the more rapid swelling of the smaller loop and an earlier death. Then there is the other factor, the cutting through of the ligature at either end of the loop by Whipple, permitting an escape of fluid from the loop, decreasing the tension within the loop, and thus preventing such a rapid swelling with consequent occlusion of the blood supply and necrosis of the intestinal wall as is found in the resected loop. This phase of the ligatured loop was studied extensively by the authors. The method consisted in ligating the duodenum with a single ligature, the size of which varied, and making no reconstruction of the canal, thus leaving the animal with an uncomplicated high obstruction. The ligature was buried with Lembert stitches. It was found that with a fairly heavy linen ligature the cutting through of the tissues and the restoration of the lumen begins in about 48 hours in the majority of instances, there being a lumen of about 1 to 2 mm. upon the 3rd day. Wide variations have been found. One dog showed a lumen of but 1 mm. after 11 days, while some showed two-thirds normal lumen after 48 hours. About 50 per cent of the dogs in which a ligature of the duodenum was done recovered completely. These dogs were tested for an immunity that they might have acquired as a result of the condition of acute obstruction which they had endured for about 48 to 72 hours.

5. Injection of the Material from Closed Intestinal Loops.—The last method of immunization was that used by Whipple; namely, the intravenous injection of the fluid from closed intestinal loops. The fluid was prepared according to the method of Whipple, with the exception that it was used within 2 or 3 days after preparation.

It is well known that many non-toxic substances, when kept in contact with such material as toluene and chloroform, may acquire a

certain degree of toxicity, and, aside from this, putrefaction is by no means prevented and any number of toxic substances may be formed which were not in the fluid at the time of collection. We were surprised to note the extreme variation in toxicity of different samples of fluid collected. 10 cc. in many instances have been fatal, while as much as 115 cc. of the undiluted fluid have caused no marked symptoms in other cases. Dogs that recovered from injections of this fluid were tested in the various ways outlined below for the existence of immunity or increased tolerance to intestinal obstruction.

Methods of Studying Immunity to or Tolerance to Intestinal Obstruction.

Production of Closed Intestinal Loops.—This is always a questionable procedure, owing to the fact that many dogs die from perforative peritonitis, to which, of course, immunity is impossible. The closed loops were made in the duodenum, as a fair proportion of the dogs die before the loop has perforated and in these dogs increased resistance can be readily observed. A dog in which the cause of death is perforative peritonitis can be easily observed after the production of the loop and the degree of resistance of the dog, in the earlier stages before the loop has perforated, noted.

Closed intestinal loops were made as a test procedure (*a*) in dogs which were strong and healthy after the open loop operation (Table I), (*b*) in dogs which had recovered from a ligatured obstruction (Table III), (*c*) in dogs from which closed loops had been removed (Table VI), and (*d*) in dogs which had previously been injected with closed loop fluid (Table VII).

Blind Duodenal Stump.—The question and method of production of a blind duodenal stump has been discussed above. Here there is no complication such as perforation and hence the results should be clear and indicative.

Blind duodenal stumps were produced in order to test the resistance (*a*) of dogs which had previously had open loops (Table II), (*b*) of dogs which had recovered from a ligatured obstruction (Table IV), (*c*) of dogs which had previously been injected with closed loop fluid (Table V), and (*d*) of a dog from which a closed loop had been removed (Table IX).

Injection of Closed Loop Fluid.—If the fluid contains the obstruction

toxin, then dogs recovered from obstruction should be more resistant to injections of it than normal dogs. On the other hand, if the fluid contains other toxic substances than that to which the dog may be expected to have increased resistance, there will be no immunity observed, following injection of the fluid, although the animal may in reality be immunized to the obstruction toxin. If, however, the other toxic substances present, as well as the obstruction toxin, are of such a nature that they can act as antigens, it is to be expected that injection of the fluid will markedly increase the resistance of the animal to the fluid. This should be true to an observable extent even if none of the toxic substances present besides the obstruction toxin have antigenic properties.

Is it not as logical to assume that if a number of toxic substances are found in the intestinal loop fluid the cause of death is due to all of them as it is to ascribe it to a particular perverted secretion, because the possible chemical nature of one toxin has been defined?

The resistance of dogs which had recovered from a ligatured obstruction, of dogs from which closed intestinal loops had been removed, of a dog which survived a closed washed intestinal loop (washing with sterile water and ether), of dogs with open intestinal loops, and of dogs which had received previous injections of loop fluid, to the injection of closed loop fluid, was compared with the resistance of normal dogs. The results are summarized in Table X. The results of injection of loop fluid into normal dogs is also included in this table to demonstrate the extreme variation in resistance that is met with normally.

Ligature of the Duodenum.—Although the percentage of recovery in normal dogs is comparatively high (about 50 per cent), it is to be expected that dogs immunized by any means to the toxin of obstruction would have such a resistance to the toxin that they would survive until the obstruction was relieved, by the cutting through of the ligature, to a much greater extent and in a greater number of cases than normal dogs. The percentage of recovery should be markedly increased. Our data on this point are not extensive for percentage results, but they are indicative.

Ligature of the duodenum was done as a test procedure only on a series of dogs which had received injections of closed loop fluid

(Table VIII). Four dogs of the seven survived over 5 weeks, which gives practically the same percentage of survival as in the control dogs given below.

Control Dogs.

Ligature of the Duodenum.—The duodenum just below the lower pancreatic duct was ligated in thirty-nine dogs with a linen ligature buried by Lembert stitches. In twenty-one dogs there was complete recovery. Seven of the remaining animals died in from 4 to 10 days from pneumonia contracted as a result of the toxemia and decreased resistance from the obstruction. The remaining eleven died in less than 96 hours with an uncomplicated autopsy picture.

Blind Duodenal Stump.—A blind duodenal stump was made in seventeen dogs by cutting the duodenum and in some instances the beginning of the jejunum, infolding the proximal end, and anastomosing the distal segment to the greater curvature of the stomach as close to the pylorus as practicable. The length of the blind stump varied from 10 to 65 cm. Two dogs are still living (3 months) and show no toxic symptoms. One died at the end of 2 months in extreme cachexia, the rest surviving the operation from 3 to 25 days. We found no direct correlation between the length of the blind stump and the degree of toxicity.

Closed Duodenal Loops.—The dogs in this series (twenty-six dogs) all died in from 24 to 96 hours, the average length of life being 48 hours. Nineteen of the loops were found to be perforated at autopsy. This gives a percentage of 73 dying from perforative peritonitis. If there is an increased tolerance in immune dogs, this percentage should be markedly increased and nearly all dogs would die as a result of the perforative peritonitis before the uncomplicated obstruction toxemia should prove fatal. None of the control dogs survived this type of loop in our series, although Sweet, Peet, and Hendrix report several instances in which the animal has lived for weeks. In the work of Dragstedt, Moorhead, and Burcky only two loops in six were found to be perforated. This gives a percentage of 33, but percentages from such a small series are misleading. Out of seven closed duodenal loops washed with water and ether, they found four perforated at autopsy.

TABLE I.

Open Loops with Later Production of Closed Loops.

Dog No.	Location of open loop.	Condition of open loop at 2nd operation.	Interval.	Location of closed loop.	Degree of toxemia preceding death.	Length of life.	Perforation.
			days			*hrs.*	
1	Duodenum.	Open.	36	Jejunum.	Toxemia after 24 hrs.	48	−*
2	"	Closed.	100	"	" " 15 "	19	+
3	"	Open.	33	"	" from start.	36	−
4	"	Closed.	21	"	" " "	60	−
5	"	Open.	26	"	Active until last few hours.	90	+
6	"	"	26	"	" " "	46	+
7	Jejunum.	"	62	Duodenum.	" " "	42	+
8	"	"	17	"	Toxemia from start.	40	+
9	"	"	24	"	" " "	26	+

* − indicates no perforation; +, perforation.

TABLE II.

Open Loops with Later Production of a Blind Duodenal Stump.

Dog No.	Location of open loop.	Condition of open loop at 2nd operation.	Interval.	Distance of blind end from pylorus.	Symptoms and remarks.	Length of life.
			days	*cm.*		
10	Jejunum.		16	38	No signs of toxemia.	Living (3 mos.).
11	"	Open.	16	42	Good recovery, then gradual decline.	7 days.
12	"		16	36	Cause of death unknown.	24 hrs.
13	"	Open.	8	45	Gradual decline.	5 days.
14	"	"	21	42	" "	5 "

TABLE III.

Dogs Recovered from a Ligatured Obstruction with Later Production of a Closed Loop.

Dog No.	Location of ligature.	Interval.	Location of closed loop.	Symptoms and remarks.	Length of life.	Perforation.
		days				
15	Lower pancreatic duct.	19	Duodenum.	Toxemia and recovery.	Living (3 mos.).	
16	" "	9	"	No toxic symptoms.	" (3 ").	
17	" "	10	"	Toxemia from start.	39 hrs.	+
18	" "	10	"	" " "	29 "	+
19	" "	9	"	" " "	32 "	+
20	Lower end of duodenum.	13	"	" " "	34 "	+
21	" "	13	"	Active until 4 hrs. before death.	56 "	+
22	" "	14	"	" " "	34 "	+

TABLE IV.

Dogs Recovered from a Ligatured Obstruction with Later Production of a Blind Duodenal Stump.

Dog No.	Location of ligature.	Interval.	Length of blind stump.	Symptoms and remarks.	Length of life.
		days	*cm.*		
23	Duodenum.	12	28	Cachexia and malnutrition.	25 days.
24	"	12	34	Pneumonia.	36 hrs.
25	"	10	38	Cachexia and malnutrition.	10 days.
26	"	9	30	" " "	20 "

TABLE V.

Dogs Injected with Closed Loop Fluid with Later Production of a Blind Duodenal Stump.

Dog No.	Times injected.	Interval.	Length of blind stump.	Symptoms and remarks.	Length of life
		days	*cm.*		
27	1	18	12	Gradual cachexia.	8 days.
28	2	9	35	" "	4 "
29	1	17	25	Lively.	Living (3 mos.).
30	1	17	36	Gradual cachexia.	5 days.

TABLE VI.

Closed Loops Removed and Second Closed Loops Made.

Dog No.	Location of 1st loop.	Interval before removal.	Condition at removal.	Interval.	Location of 2nd loop.	Symptoms and remarks.	Length of life.	Perforation.
		hrs.		*days*			*hrs.*	
31	Jejunum.	30	$\frac{4}{4}$*	28	Duodenum.	Toxemia from start.	34	+
32	"	21	$\frac{2}{4}$	19	Jejunum.	Mild toxemia from start.	48	+
33	"	20	$\frac{4}{4}$	15	Duodenum.	Active till 2 hrs. before death.	36	+
34	"	34	$\frac{3}{4}$	13	"	Toxemia from start.	30	+
35	"	72	$\frac{3}{4}$	7	"	Mild toxemia throughout.	38	−
36	"	48	$\frac{3}{4}$	6	"	Sudden onset of toxic symptoms 2 hrs. prior to death.	26	+
37	"	34½	$\frac{2}{4}$	40	"	Toxemia continuous.	48	−

*$\frac{4}{4}$ indicates distention to point of perforation; $\frac{1}{4}$ indicates beginning distention, etc.

TABLE VII.

Dogs Injected with Closed Loop Fluid with Later Production of Closed Loops.

Dog No.	Times injected.	Interval.	Location of closed loop.	Symptoms and remarks.	Length of life.	Perforation.
		days			*hrs.*	
38	1	27	Duodenum.	Mild toxemia.	36	+
39	1	12	"	" "	50	+
40	2	12	"	Active until last few hours.	38	+
41	1	8	"	" "	42	+
42	1	8	"	Toxemia from start.	28	−
37	1	12	"	" continuous.	48	−
43	1	7	Jejunum.	" "	24	−

TABLE VIII.

Dogs Injected with Closed Loop Fluid with Later Ligature of the Duodenum.

Dog No.	Times injected.	Interval.	Location of ligature.	Symptoms and remarks.	Length of life.
		days			*days*
44	3	7	Lower pancreatic duct.	Gradual toxemia.	7
45	3	7	" " "	" "	9
46	2	9	" " "	" "	5
47	1	20	" " "	Beginning toxemia after 24 hrs.	36
48	2	3	" " "	Complete recovery.	
49	1	4	" " "	Toxemia after 24 hrs.	48
50	1	5	" " "	Complete recovery.	

TABLE IX.

Closed Loop Removed with Later Production of a Blind Duodenal Stump.

Dog No.	Location of loop.	Condition at removal.	Interval.	Length of blind stump.	Symptoms and remarks.	Length of life.
			days	*cm.*		*days*
30	Jejunum.	¾ distended.	34	36	Toxemia after 2nd day.	5

TABLE X.

Comparative Resistance of Dogs to the Injection of Closed Loop Fluid.

Fluid.	Dog No.	Condition of animal.	Weight.	Amount injected.	Amount per kilo.	Result.
			kg.	*cc.*	*cc.*	
W. R.	43	Normal.	6	6	1	Toxemia and recovery.
"	51	"	11	24	2.2	" " "
"	52	"	8.3	24	2.9	Dead in 5 hrs.
"	53	"	5.5	24	4.3	" " 8 "
"	16	Ligature and closed loop.	8	16	2	" " 18 "
A_2	29	Normal.	8	40	5	Good recovery.
A_2	54	"	8	80	10	Toxemia and recovery.
A_2	55	"	8	105	13	Dead in 10 hrs.
A_2	56	Closed loop removed.	6	33	5.5	Good recovery.
A_2	30	" " "	10	120	12	" "
A_2	57	" " "	10.5	105	10	Toxemia and recovery.
404	46	Normal.	9.4	28	3	Good recovery.
404	58	"	11	33	3	" "
404	38	"	8.9	27	3	Marked toxemia and recovery.
404	27	"	9	54	6	Good recovery.
404	59	Open loop.	6.3	19	3	" "
404	44	Two previous injections.	10.4	3.	3	" "
404	45	" " "	12.5	38	3	Toxemia and recovery.
404	60	Open loop.	10.4	31	3	Marked toxemia and recovery.
404	46	One previous injection.	9.4	50	5.3	" " "
404	61	" " "	11	60	5.5	Dead in 6 hrs.
439	49	Normal.	7.7	45	5.8	Good recovery.
439	50	"	13	100	7.7	Toxemia and recovery.
439	48	One previous injection.	7.3	49	6.7	" " "
439	62	" " "	6	60	10	Dead in 12 hrs.
XO2	47	Normal.	13.2	33	2.5	Good recovery.
XO2	63	"	6.4	32	5	" "
XO2	64	"	7.3	50	6.7	Dead in 8 hrs.
XO2	65	"	5.7	17.1	3	" " 8 "
XO2	66	"	13	98	7.5	" " 6 "
XO2	67	Open loop and closed washed loop.	8.6	27	3.1	Toxemia and recovery.
XO2	68	Open loop.	14.2	100	7	Good recovery.
XO2	69	One previous injection.	7	50	7.1	Dead in 4 hrs.
XO2	37	Closed loop removed.	10.7	32	3	Toxemia and recovery.
658	39	Normal.	17	102	6	Good recovery.
658	40	"	12	72	6	Toxemia and recovery
658	28	"	5	45	9	Good recovery.
27	70	Normal.	8	6	0.8	Dead in 19 hrs.
27	44	"	10.4	15	1.4	Toxemia and recovery.
27	45	"	12.5	5	0.4	" " "

DISCUSSION.

With few exceptions immunized dogs showed no greater resistance to subsequent obstruction than normal dogs, and in many instances they showed less. Two dogs that recovered from a ligation of the duodenum survived a closed unwashed duodenal loop, and are still living after 3 months. Upon later examination these loops were found to be only moderately distended and of good color. So far we have had no normal dogs survive a closed duodenal loop to this extent, but we are inclined to believe that the previous obstruction has altered the secretion-absorption ratio so that upon production of a closed loop there was no distention with consequent tissue necrosis, inasmuch as Sweet, Peet, and Hendrix report several instances of a normal dog surviving closed loops, and Dragstedt, Moorhead, and Burcky have shown that dogs can survive closed loops washed with ether. We do not consider that any immunity is shown by these cases. One dog immunized by injection survived a blind duodenal stump indefinitely. Controls have done this, however, and this is, therefore, no indication of an increased resistance.

Of the twenty-nine closed loops produced in immune dogs, twenty-one were found to be perforated after death. This gives a percentage of 72 for dogs dying of perforative peritonitis, which is no higher than that in control dogs and indicates that the immune dogs have no greater resistance to the toxemia than control dogs.

There still remains the possibility of an increased tolerance to the poison of intestinal obstruction. It is well known that carrion-eating animals can ingest quantities of putrefying protein that would poison man. What is the nature of the resistance to the poisons, and is it possible that dogs recovered from intestinal obstruction might show a slight increased tolerance to a later similar condition?

Our experiments so far do not indicate an increased tolerance, but if there is a tolerance of slight grade, it would take a great many experiments to demonstrate it. If this should prove to be the case, we believe that our work warrants the statement that the increased tolerance is due to some variable factor, such as diminished absorption in that section of intestine which was affected by the obstruction, since an increased tolerance has not been noticeable in a great number of our experiments.

CONCLUSIONS.

1. There is no increased immunity or tolerance to intestinal obstruction after recovery from previous obstruction.

2. Dogs recovered from intestinal obstruction are not more resistant to injections of closed loop fluid than normal dogs.

3. Dogs injected with closed loop fluid are not more resistant to intestinal obstruction than normal dogs.

4. In dogs the normal variation in resistance both to intestinal obstruction and to the injection of closed loop fluid is large.

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