

ella tularensis. This strain of *Pasteurella tularensis* has been preserved as Minnesota No. 31.

Identification of the organism was established by the typical lesions of the disease produced by its growth only on a medium containing cystine, by morphological characters, and by the following agglutination tests, which showed a prozone for the organisms isolated from both birds.

The recognition of natural infections of tularemia in quail, sage hens, sharp-tailed grouse, and ruffed grouse, indicates that this disease is widely distributed among species of game bird.

6456

Absorption of Strychnine Sulphate from Strangulated Segments of Bowel.*

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Death, following strangulation of the intestine in man and the experimental animal, is usually attributed to a resulting toxemia. There has been considerable controversy as to the nature of the toxic material, and its route of absorption. To throw light on possible avenues of absorption, a product of known toxicity was introduced into the lumen of strangulated segments of dogs' intestines. Strychnine sulphate was chosen for the toxic substance, as it produced unmistakable clinical symptoms when present in relatively minute doses.

Controls. 50 mg. doses of strychnine sulphate were introduced into the lumen of the normal small intestine of 3 dogs. Similar doses were placed free in the peritoneal cavities of 2 other dogs. All 5 developed definite signs of irritability, followed by convulsions in from 3 to 8 minutes, and subsequent death.

Experiments. 50 to 150 mg. doses of strychnine sulphate were then introduced into the lumen of strangulated segments of bowel. Four types of strangulation were employed. In each type the lumen of the normal bowel, proximal and distal to the strangulated segment, was occluded by tying binding tape firmly about the bowel wall. A small window was first made in the mesentery between the

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vascular arcades adjacent to the bowel wall. The anastomosing vessels running parallel to the bowel wall were then doubly ligated and cut between ligatures, the tape passed about the serosa of the bowel wall and tied. In some experiments the loop chosen for strangulation was isolated by completely severing it from the rest of the bowel, thus making it a closed loop. These experiments are designated in the tables as closed loops (C.L.). In this manner, the segment of bowel selected was completely isolated except for its own vascular bed. The blood supply was then partially or completely obstructed by one of 4 methods. In Group I, all of the arteries to the loop were doubly ligated and severed between ligatures. The veins and lymphatics were left intact in order not to prevent the possibility of venous or lymphatic absorption. In Group II, the veins were doubly ligated and cut between ligatures. The arteries were left intact. The lymphatics, in most instances, were undoubtedly obstructed with the veins, as the mesentery was frequently ligated en masse after freeing the artery from its mesenteric sheath. In Group III, arteries, veins, and lymphatics were all obstructed as the mesenteric pedicle was doubly ligated and cut between ligatures. In Group IV, an encircling ligature of binding tape was passed about the mesenteric pedicle and tied with varying degrees of tension, to obtain variations in the degree of venous and arterial occlusion in order to simulate the conditions that obtain clinically.

In Group I, ten experiments in which the arteries alone were tied, none of the signs of strychnine poisoning, irritability, or convulsions developed during the life of the animals. The average length of life for the group was 16.7 hours. At autopsy, these animals had several hundred cc. of a bloody serous fluid in the peritoneal cavity. The strangulated loops were dark red in color and the lumen was only slightly to moderately filled with a bloody fluid. The wall was about of normal thickness. In no instance was there any evidence of gross perforation. Samples (10-20 cc.) of the peritoneal fluid were injected intraperitoneally into 4 guinea pigs and smaller samples, 3-5 cc., were injected into the dorsal lymph sac of 3 frogs. The pigs did not develop convulsions. The 3 frogs developed delayed convulsions. Convulsions came on in from 12 to 45 minutes.

In Group II, nine experiments in which the veins and lymphatics were ligated, 3 of the 9 animals developed convulsions. The average length of life was 8 hours. At autopsy, the peritoneal cavity contained serous fluid with a bloody tinge. The strangulated loops were dark red in color and their lumen markedly distended with fluid. The loops were extremely heavy in contrast to the undis-

tended loops in Group I. In the 3 cases in which convulsions developed prior to death, bloody fluid from the strangulated loop was found in the lumen of the adjacent normal bowel. This apparently resulted from the extreme distension of the lumen of the loops. This filling of the lumen of the strangulated loop and its subsequent distension was seen in all strangulations of this type and is due, undoubtedly, to seepage of blood through the mucosa of the strangulated loop in consequence of the complete venous obstruction in the face of fully patent arteries which are constantly delivering blood into the wall of the gut. Samples of peritoneal fluid introduced into frogs, as in Group I, were positive for strychnine in 2 instances. In 2 other experiments, there was no evidence of strychnine in the peritoneal cavity after as long a survival period as 20 hours. In 2 experiments, a catheter was tied in the peritoneal cavity and aspirations of the peritoneal fluid were made every 30 to 45 minutes. Three cubic centimeter samples of the fluid were injected immediately upon aspiration into the dorsal lymph sac of 6 frogs. In the first experiment, the first frog developed signs of irritability in 30 minutes and convulsions in 1 hour. The last 5 frogs developed no signs of irritability and none had convulsions. However, the dog had convulsions at the time of last aspiration. In the second experiment, none of the frogs developed irritability or convulsions, neither did the dog have convulsions.

In Group III, ten experiments in which the mesenteric pedicle was completely ligated and severed, 4 animals developed signs of irritability or convulsions during life. The average length of life for the 8 animals that died in this group (2 were killed) was 16 hours. The autopsy findings were almost identical to those in Group I in which the arteries alone had been severed. All of the loops were necrotic, but none showed gross perforations. In 8 instances the frog test for strychnine in the peritoneal cavity at the time of death was negative and in 2 it was positive. In 3 experiments in this group a catheter was tied in the peritoneal cavity and samples of peritoneal fluid were aspirated at hourly intervals for 5 hours and at time of the animals' death; 3-5 cc. of each sample were injected immediately upon aspiration into the dorsal lymph sac of a frog. None of the frogs showed either irritability or convulsions after injection with samples removed during the life of the animals. Two frogs developed convulsions following injection with post-mortem peritoneal fluid. In Group IV, three experiments in which an encircling ligature was placed about the mesenteric pedicle, all of the animals developed convulsions during life. The

average length of life was 8 hours. At autopsy, the findings were quite similar to those in Group II, in which the veins were ligated, the arteries being left intact. Inability to completely arrest absorption through the mesenteric pedicle by an encirclement ligature undoubtedly accounts for the absorption of strychnine in these animals. Frog tests of the peritoneal fluid were negative for presence of strychnine. One animal had a loop with a gross perforation at time of death. Five cc. of this fluid killed a rabbit in 3 minutes when injected intraperitoneally. The rabbit developed marked convulsions within the first minute after injection. A sample of peritoneal fluid taken from this same animal at operation 7 hours previously and 8 hours following the onset of the strangulation was negative for strychnine.

Conclusions. 1. Strychnine sulphate is quickly absorbed from the lumen of the normal bowel and from the peritoneal cavity. 2. Interference with the blood supply of a segment of bowel prevents or

TABLE I.
Arteries Ligated. 50 mg. Given. No Convulsions.

Length	Survival Time	Frog Test
inches	hr.	
6 C.L.	20	+ 45'
30 "	5	+ 12'
36 "	14	+ 15'
24 —	7	
30 C.L.	17	Pigs (—)
18 "	28	" (—)
24 —	21	
36 —	22	
40 —	18	
40 —	15	
	Av. 16.7	

C.L., closed loop. —, regular method (exclusion of segment of gut with binding tape).

TABLE II.
Veins Ligated.

Length	Quant.	Survival Time	Convulsion	Frog Test
inches	mg.	hr.		
40 —	50	6	No	
36 —	"	4	"	Perit. fluid +30', Loop +5'
36 —	"	10	Yes (8 hr.)	" " " " "
30 —	"	7	" (2 hr.)	
40 —	"	6½	No	
36 —	"	7½	"	
36 —	"	6	"	
36 —	150	4	Yes	1st Spec. +, Others (—)
36 C.L.	"	20	No	Frog (—), Dog (—)
		Av. 8 hr.		

—, regular method (exclusion of segment of gut with binding tape), C.L., closed loop.

STRYCHNINE ABSORPTION IN STRANGULATION OBSTRUCTION 291

TABLE III.
Complete Division of Mesentery. 50 mg. Given.

Length	Type	Survival Time	Convulsions	Frog Tests
inches		hr.		
18	C.L.	30	No	Postmort. spec. +
24	R.	13	"	" " —
12	C.L.	16	"	" " —
36	R.	18	"	5 antemort. spec. —
36	"	20	"	5 " " —
24	"	13	Yes—12 hr.	Postmort. spec. +
24	"	15	" 14 "	" " —
24	C.L.	9	" 6 "	4 antemort. spec. —
30	"	8 (killed)	" 7 "	Postmort. spec. —
15	"	7 (killed)	No	" " —

C.L., closed loop. R, regular method (exclusion of segment of gut with binding tape).

TABLE IV.
Encirclement Ligature.

Length	Quant.	Survival Time	Convulsion	Frog Test
inches	mg.	hr.		
24	150	4½	Yes	(—)
36	"	7	"	(—)
40	"	8	No	
40	(Gross perforation)	15	Yes	Rabbit (+)
		Av. 8½		

greatly delays the absorption of strychnine from the lumen. 3. Complete arrest of blood flow to (arterial occlusion) or from the bowel (venous occlusion) probably precludes absorption through the mesenteric vessels. 4. Evidence of transperitoneal absorption was demonstrated in some of these experiments but only through gut wall whose nutrition was seriously damaged. In the absence of gross perforation or rupture of the gut wall, transperitoneal absorption is slight even in the presence of a badly damaged wall.