TABLE

To 0.2 cc. of a solution of the sodium salts of the dyes (prepared with resorcinol) in saline in a concentration of 0.01 or 0.002%, 1 or 2 capillary drops of immune serum were added. Readings were taken after 2 hours at room temperature and after standing over night in the icebox. The intensity of the reactions is indicated as follows: 0, ftr (faint trace), tr (trace), *tr* (strong trace), ±, +, +±, etc.

Immune sera for azoproteins made from	Reading taken after	Dyes made from: p-amino succinanilic acid 0.01%	p-amino succinanilic acid 0.002%	p-amino adipanilic acid 0.01%	p-amino adipanilic acid 0.002%	p-amino suberanilic acid 0.01%	p-amino suberanilic acid 0.002%
p-amino-succinanilic acid 1 drop	2 hours	tr	+	0	0	0	0
	Night in icebox	+	++	0	0	0	0
p-amino-adipanilic acid 2 drops	2 hours	0	0	*tr*	*tr*	0	0
	Night in icebox	0	0	+±	+	tr	0
p-amino-suberanilic acid 1 drop	2 hours	0	0	±	±	++	++
	Night in icebox	0	0	+±	+±	+++	++±

inhibited specifically by the addition of the nitroanilic acids. Weak but definite precipitin reactions were also obtained with azodyes prepared from aminotartranilic acid and p-arsanilic acid, and the homologous immune sera.

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Blood Losses in Experimental Intestinal Strangulations and Their Relationship to Degree of Shock and Death.*

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Most investigators and clinicians believe that death in intestinal strangulation is due to toxemia resulting from absorption of toxic products from the lumen or wall of the strangulated bowel.[1, 2] It was previously observed that the fall in blood pressure was intimately correlated with the type, length (of bowel) and duration of strangulation.[3] In this study the blood losses accompanying varying types of strangulation will be detailed.

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1 VonAlbeck, *Arch. f. klin. Chir.*, 1902, **65**, 569.

2 Murphy, Fred T., and Vincent, Beth, *Boston Med. and Surg. J.*, 1911, **165**, 684.

Methods. The data presented here on blood volume losses were obtained from experiments on 38 animals. As in the other phases of this work[3, 4] the intestinal strangulations were divided into 4 groups. *Group I.* 11 dogs. The veins to varying lengths of intestine (3-5½ ft.) were completely tied off and the animals were autopsied immediately after death. *Group II.* 11 animals. An encircling ligature was passed about the bowel wall and mesenteric pedicle to loops of bowel of varying length (1-5 ft.), and the loops resected when the animals appeared moribund 2 to 5 hours later. In this group the degree of venous and arterial occlusion depended entirely upon the tightness of the constricting mechanisms. In practically every case the venous occlusion was complete while the arterial occlusion was only partial. *Group III.* 9 animals. The arteries and veins to loops of bowel varying between one and 5 feet were completely ligated and severed and the dogs were autopsied immediately after death. *Group IV.* 7 animals. The arteries to one to 4 foot loops were completely ligated, the veins being left intact, the animals autopsied shortly after death.

At necropsy, in each instance, the peritoneal fluid was measured; the gut with its contents was weighed; the contents were removed and the gut reweighed. The gut length was measured just prior to the strangulation and in some instances afterwards as well. The amount of blood lost was calculated as being equivalent to the peritoneal fluid plus the increase in gut weight over the calculated normal. The reasons for believing that these figures give an estimate of the true blood losses in the first 2 groups can be seen from a careful study of the results. The blood volume loss was calculated from these figures, basing the total blood volume on an arbitrary figure of 7.5% of the body weight, this figure being given by most authors as the maximum figure for total blood volume.

Results. In Group I, venous ligations, shock symptoms and death resulted very soon. Within 2 hours the animals began to show a definite increase in the respiratory and cardiac rates. The hemoglobin had begun to fall as well as the blood pressure. In a few animals in which the abdomen was opened after this time interval the strangulated gut was seen to be of a dark mahogany color, lusterless, and distended. The distension was due to a dark, bloody fluid which had accumulated within the wall and lumen of the bowel.

[3] Scott, H. G., and Wangensteen, O. H., PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 748.

[4] Scott, H. G., and Wangensteen, O. H., PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 748.

Hemoglobin determinations revealed this fluid to have a hemoglobin content ranging from 60 to 140% (Sahli) of normal blood. The peritoneal cavity usually contained a bloody serous fluid. Hemoglobin content was usually less than 10%, but the total protein content was always about that of the animal's own blood plasma. At the time of death, gross and microscopic sections of the gut revealed the wall to be packed with red blood cells. Weight determinations of the empty gut showed that the wall was so filled with blood that the weight of the gut had increased from 150 to 500% in every instance. All these findings were minimal shortly after producing the strangulation and increased during the course of the strangulation, reaching a maximum at the time of death. Death in Group I occurred after a loss of from 34 to 66% of the total blood volume. The average for the group was 55% and the average length of life was 5½ hours. In Group II, encirclement strangulation, in which there was only partial arterial occlusion and the loops were resected before the animals died the blood volume losses were less, varying from 20 to 50%, with an average of 35% for the entire group. In Groups III and IV in which there was complete arterial occlusion the gut was found to be ruptured in 13 out of 16 instances. In those instances where it was not ruptured there was very little fluid within the lumen. In none of the dogs of these last 2 groups was there found to be any increase in the gut weight of the strangulated loop over the normal. Consequently no figures are listed for these 2 groups with reference to the gut weight.

In those instances where the loops were ruptured, the peritoneal cavity was found to contain rather large amounts of peritoneal fluid of rather high total protein content, the values ranging from that of the animal's own blood plasma up to twice the amount. In the few instances in which the loops were not ruptured the peritoneal fluid had a total protein content less than that of the blood plasma. The amount of fluid found in the peritoneum was calculated to be 22% of the total blood volume in the third group and 20% in the fourth group. A summary of the data will be found in the table.

Comment. The rapid fall in blood pressure, early shock, and death in Group I are associated with a loss of blood sufficient in itself to produce these results. The same is true of Group II. We feel, therefore, that the results obtained in Groups I and II confirm the work of Blalock,[5] who contends that the fall in blood pressure in shock is due to blood losses. However, in Groups III and IV in

[5] Blalock, Alfred, *Arch. Surg.*, 1930, **20**, 959.

TABLE I.

		Dog wt. kilos	Gut length ft.	Strang. time hr.	Peritoneal fluid cc.	Gut wt. gm.	Normal gut wt. gm.	Increase gut wt. %	Total blood loss gm.	Blood volume loss %
Group I	Minimum	8	3.0	2.5	30	260	90	150	260	34
	Maximum	22	5.5	12.0	300	1030	170	490	1015	66
	Average	15	4.3	5.5	96	680	135	283	643	55
Group II	Minimum	11	2.0	2.0	30	240	76	133	180	20
	Maximum	21	5.0	5.5	140	675	150	320	635	50
	Average	15	3.2	4.0	82	460	103	235	425	35
Group III	Minimum	5	1.0	15.0	40	—	—	—	—	48
	Maximum	14	5.0	32.0	325	—	—	—	—	48
	Average	9	2.5	20.0	142	—	—	—	—	22
Group IV	Minimum	8	1.0	15.0	40	—	—	—	—	14
	Maximum	20	4.0	24.0	350	—	—	—	—	30
	Average	15	2.5	20.0	250	—	—	—	—	20

which the arteries are ligated some factors other than whole blood losses must apparently enter in to play the major rôle in the cause of death.

Summary. Data are submitted on 38 animals in which 4 types of strangulation obstruction were produced and followed until death ensued in 3 of the 4 groups. In Group II, the strangulated loops were resected before death, at a time when the animals appeared moribund.

In the first 2 groups in which the veins were occluded, the arteries were patent or only partially occluded. In these groups the animals apparently died from loss of blood into the bowel and peritoneal cavity. In the last 2 groups in which the arterial occlusion was complete the animals lived about 4 times as long, and undoubtedly died from factors other than the loss of whole blood. Just what caused death in these last 2 groups we are unable to say at this time.

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A Technic that Facilitates Lumbar Puncture in the Dog.

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In the last year we studied spinal anesthesia for the dog, and a number of difficulties have been overcome by the utilization of a simple piece of apparatus and the adoption of a certain routine in