than those reported by Bruhn[9] and about 20% higher than those reported by Rakieten.[10] The monkeys were not trained in the apparatus and none of the experiments were performed at night as suggested by Bruhn[9] so that the control values may be slightly higher than the true basal rate.

The data that were obtained during the control period and during the period following the administration of the delvinal sodium, are shown in Table I. The metabolic rate changed so slowly during the narcosis resulting from the delvinal sodium that the instantaneous values at the arbitrary times selected give a graphic picture of the smooth curve obtained. The degree of anesthesia was difficult to judge but the following criteria were adopted: (1) deep surgical anesthesia when there was no response to any stimuli, (2) light surgical anesthesia when there was reflex response to a severe pinch in the flank, and (3) very light anesthesia when there were no voluntary movements but when a painful stimulus temporarily caused coordinated movements.

It is interesting to note that there was a significant decrease in the oxygen consumption in every animal that received delvinal sodium. However, this decrease in oxygen consumption does not seem to be related to either the dose of the drug or the drop in rectal temperature during the experimental period.

Summary. The average basal heat production of ten normal rhesus monkeys was 30.46 cal/square meter/hour. The O_2 consumption was decreased by doses of 30 mg to 45 mg of delvinal sodium/kilo of monkey. The 40 mg and 45 mg doses/kilo produced surgical anesthesia that lasted for about 3 hours to 5 hours.

13328

Blood Enzymes after Ligation of all Pancreatic Ducts.*

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Ligation of the pancreatic ducts of dogs is soon followed by a rise in the concentration of blood amylase which has been assumed by

[9] Bruhn, J. M., *Am. J. Physiol.*, 1934, **110**, 477.

[10] Rakieten, N., *J. Nutrition*, 1935, **10**, 357.

* Aided by the John D. and Fannie K. Herz Fund.

most workers in this field to return to the previous level within 10 days to a few weeks, with occasional transient rises up to the sixth week.[1] Golden, Sieracki, Handelsman and Pratt[2] reported that following ligation and section of all pancreatic ducts, a permanent increase of blood amylase resulted in 3 out of 4 dogs. Autopsy showed the pancreas to be transformed into a small thin, cordlike mass in all 4 dogs. None of their animals had been suffering from nephritis.[2, 3] Popper and Plotke[4] in recently published animal experiments, demonstrated that an artificially raised blood enzyme level falls to normal within a few hours, if no further inflow of enzymes into the circulation takes place. Since the pancreatic enzymes are produced only in the acinar tissues of the pancreas, it is difficult to understand how blood amylase can remain at an increased level in case of a complete atrophy of the acinar tissues. It is known, of course, that the pancreas is not the sole source of blood amylase, and following total pancreatectomy blood amylase soon returns to its control level. In case of increased blood amylase, however, no other source is known than the pancreas, or, rarely, the salivary glands.[5]

In order to explain the above, the pancreas of 4 dogs was isolated from the duodenum in exactly the same way as Golden and collaborators have reported. All connecting strands were ligated and divided and only the necessary blood vessels remained intact. Omentum was interposed between duodenum and pancreas to avoid the possibility of recanalization. Two of the 4 dogs died from pancreatitis. The remaining 2 were kept alive for 12 months. One of them lost weight slowly but continually. The other dog retained its original weight until 9 months after operation, when it began to drop suddenly. Both dogs died 12 months after operation from an intercurrent disease, and a thorough necropsy was performed. In both animals a small, thin, cordlike mass was found, which did not resemble the pancreas at all. Microscopic examination showed an abundance of connective tissue, containing many nerve fibers, blood vessels and islets of Langerhans. In a few places small nests of cells were found which seemed to be acinar tissue.

Table I shows the enzyme concentration in the blood of the 2 dogs before and after operation. Blood amylase was determined by the

1 Gould, L. K., and Carlson, A. J., *Am. J. Physiol.*, 1911-12, **29**, 165.

2 Golden, L. A., Sieracki, L. A., Handelsman, M. B., and Pratt, J. H., *Am. J. Dig. Dis.*, 1939, **6**, 327.

3 Gray, S. H., and Somogyi, M., PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 1126.

4 Popper, H. L., and Plotke, F., *Surgery*, 1941, **9**, 706.

5 Popper, H. L., Hirschhorn, S., and Selinger, A., *Klin. Wochen.*, 1931, **10**, 493.

Wohlgemuth method; normal values for the dog range between 32 and 128 Wohlgemuth units. Blood lipase was determined, using Crandall and Cherry's method[6] and the values are expressed in cc of N/20 NaOH, 1cc being equal to one unit. Lipase values up to 1.0 cc are normal in dogs, according to our experience.

Dog 1 showed a marked increase of blood amylase 24 hours after ligation of the pancreatic ducts. The next enzyme determination, performed 11 days after the operation, revealed normal blood amylase which did not change during the following 12 months of observation. Lipase was not found changed, but it is possible that a rise of lipase had taken place between the 1st and 11th postoperative day, since no lipase determination was performed in this period.

Dog 2 showed a marked increase of blood amylase 1 day after the operation, and 6 days after operation still a slight increase. The next

TABLE I.
Blood Enzymes Following Ligature of All Pancreatic Ducts.

Time	Wohlgemuth units Amylase	cc N/20 NaOH Lipase	Weight, lbs
Dog 1			
Before operation	64	.2	41
After operation			
1 day	1024	.2	
11 "	32	.4	
3 wk	64	.7	28
6 "	128		26½
9 "	128	.3	25½
11 "	64	.7	
14 "	128	.2	27
20 "	128	.8	25
24 "	128	.4	22½
7 mo	128		
8 "	64	.8	
10 "	64	.4	20
11 "	64	.6	17
Dog 2			
Before operation	128	.6	35
After operation			
1 day	1024	.4	
6 "	256	.8	
23 "	128	.3	32
6 wk	1024	3.1	32
8 "	128	.8	
11 "	512	.9	
13 "	512	.4	36½
17 "	128	.8	36
21 "	128		34
6 mo	64		
7½ "	64	.8	33
9 "	64	.6	33
10½ "	64	.6	28
12 "	64	.2	22

[6] Crandall, L. A., Jr., and Cherry, I. S., *Am. J. Physiol.*, 1932, **100**, 266.

determination, performed on the 23rd postoperative day, revealed a normal concentration of blood amylase. In the 6th postoperative week a marked rise of amylase was again found, but after 8 weeks a normal level was present. From the 11th to the 13th week, a third rise was observed. From then on its concentration remained permanently below the preoperative level. Blood lipase showed no increase following the operation, but a marked rise accompanied the secondary rise of amylase in the 6th postoperative week. Further determinations revealed values within normal limits. Our observations on blood lipase confirm similar ones by Chiray, Berdet and Taschner.[7]

Antopol, Schifrin and Tuchman[8] and Friedman and Thompson[9] have shown that injection of Mecholyl†-eserine is followed by an increase of blood amylase provided that functioning pancreatic tissue is present, and we[4] have reported similar results on blood lipase. We have tried, therefore, to stimulate the pancreas of our experimental animals with Mecholyl-eserine, 24 and 21 weeks respectively after ligation of the pancreatic ducts. Neither an increase of amylase nor of lipase occurred, suggesting the absence of functioning pancreatic tissue.

Our findings are in line with our present knowledge about blood amylase. An increase occurs following retention of the external pancreatic secretion and Hess[10] has shown that the congested pancreas ceases secreting very soon. Following this, no further absorption of enzymes into the blood circulation takes place and the increased blood enzyme level will drop within a very short time as we have demonstrated recently.[4]

The process of secretion by the pancreas and subsequent absorption of enzymes may repeat itself and may last a certain time. It is certainly to be thought of not only as a simple mechanical process, but also due to inflammatory reactions of the pancreas. However, after a few months the atrophy of the pancreas is completed, the acinar tissue has disappeared, and no further production and consequent absorption of enzymes can take place. Yet, blood amylase does not disappear entirely but remains at a low level which, according to observa tions on pancreatectomized dogs, must be derived from other sources.

It is obvious that drugs, increasing the concentration of blood

[7] Chiray, M., Berdet, H., and Taschner, E., *Arch. d. mal. de l'app. digestif*, 1931, **21**, 1137.

[8] Antopol, W., Schifrin, A., and Tuchman, L., PROC. SOC. EXP. BIOL. AND MED., 1934, **32**, 383.

[9] Friedman, I., and Thompson, W. R., *Ann. Surg.*, 1936, **104**, 388.

† Acetyl-beta-methylcholine HCl

[10] Hess, O., *Grenzgebiete der Medizin und Chirurgie*, 1909, **19**, 637.

enzymes by stimulation of the pancreas cannot cause any change at this stage.

Summary. In 2 dogs separation of the pancreas from the duodenum with permanent occlusion of all pancreatic ducts was followed by a transient increase of blood amylase. No permanent increase of blood amylase was found as has been reported by others. The dogs showed no increase of blood lipase after the operation. One of these dogs had a secondary and tertiary rise of blood amylase as described by Gould and Carlson, and a transient rise of blood lipase coincident with the secondary rise of amylase.

13329

Sulfonamide Compounds in Treatment of Experimental *B. typhosus* (*Eberthella typhosus*) Infections of Rabbits.

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Buttle, Parish, McLeod and Stephenson[1] found that p-aminobenzenesulfonamide protects mice against multiple lethal doses of *B. typhosus* and *B. paratyphosus B.* Kolmer and Rule[2] also observed that sulfanilamide administered by subcutaneous and intraperitoneal injection was slightly effective in the treatment of mice inoculated intraperitoneally with *B. typhosus* but noted that sulfapyridine was less effective.

In the present investigation sulfanilamide, sulfapyridine and sulfathiazole were employed by oral administration in the treatment of rabbits inoculated intravenously with *B. typhosus.* The strain employed was of such virulence that the intravenous injection of 0.6 cc of 24-hour broth culture per kilo produced a rapidly fatal infection. Since it was desired to produce a prolonged infection for treatment purposes rabbits were given 0.2 cc of culture per kilo intravenously at daily intervals for 6 days. As a general rule 3 inoculations at daily intervals produced fatal infections with positive heart blood cultures and this amount was employed in order to avoid overwhelm-

[1] Buttle, G. A. H., Parish, H. J., McLeod, M., and Stephenson, D., *Lancet*, 1937, **1**, 681.

[2] Kolmer, J. A., and Rule, A. M., PROC. SOC. EXP. BIOL. AND MED., 1939, **40**, 615.