larger doses of bacteria the period after injection of organisms at which protection was obtained with phage, was shortened.

In another series of experiments bacteriophage was given subcutaneously, while the organisms were injected intraperitoneally. In these experiments, only mice inoculated with bacteriophage simultaneously or 15 minutes after the injection of bacteria could be saved. The mice inoculated with bacteriophage at later periods succumbed at the same time as the controls. When mice which had survived these experiments were autopsied several days later no signs of peritonitis were found, and yet from the peritoneal exudate and blood the bacteriophage was recovered. All of these experiments have been repeated several times and our results have been consistent. The results seem to offer encouragement for further experiments in this field.

6061

Return of Gastric Acidity after Subtotal Gastrectomy and Double Vagotomy.

P. F. SHAPIRO AND B. N. BERG.

From the Department of Surgery, the Presbyterian Hospital, and the Department of Pathology, College of Physicians and Surgeons, Columbia University.

The following study was undertaken to determine the influence of subtotal gastric resection and double vagotomy upon gastric acidity in dogs. Portis and Portis[1] showed that the total acidity remained unaltered after subtotal gastrectomy in dogs. Hartzell[2] found a marked reduction in acid after supra-phrenic double vagotomy, but 2 years later Vanzant[3] working with the same animals reported that the acid had returned to normal values.

Complete studies have been made upon 5 dogs. Preliminary to resection and vagotomy, a Pavlov pouch was made. Then, 2 to 3 weeks later when the acidity of the pouch was stabilized, the second operation was performed. This consisted of isolation and division of the anterior and posterior vagal trunks on the abdominal portion of the esophagus and resection of the distal portion of the stomach from a point approximately 3 cm. proximal to the *incisura angu-*

[1] Portis, S. A., and Portis, B., *J. Am. Med. Assn.*, 1926, **86**, 836.

[2] Hartzell, J. B., *Am. J. Physiol.*, 1929, **91**, 161.

[3] Vanzant, F. R., *Am. J. Physiol.*, 1932, **99**, 375.

laris to just beyond the pyloric ring, thus insuring complete removal of the antrum and pylorus. The stump of the duodenum was closed and an anterior Polya gastro-jejunostomy was established. For the study of gastric secretion a test meal consisting of lean meat and water was used. Specimens were obtained for analysis from the intact stomach before operation; from the pouch and main stomach 12 days after the first operation; and from the pouch and gastric remnant for 6 to 12 weeks after the second operation. The samples were aspirated at hourly intervals for periods of 4 to 7 hours after the administration of the test meal and were examined for free, combined, and total acidity by titrating against N/10 sodium hydroxide. In addition, the effect of atropine upon the secretory response to a test meal was studied before and after subtotal removal of the stomach and section of the vagi.

The following results were obtained. Before gastric resection and vagotomy, maximum total acidities of 85 to 100 clinical units were reached in the main stomach. Higher figures up to 100 and 120 units were present in the secretion from the pouch. Two mg. of atropine reduced the acidity about 50%, but after a few hours the acid returned to its original level. The highly acid juice which poured out of the pouch began to digest the adjacent skin and only daily neutralizing dressings controlled this action.

After gastrectomy and vagotomy the acidity was diminished for a period of 2 to 4 weeks. The maximum total acidity in the main stomach remnant in response to the test meal dropped to 30 or 40 clinical units and in the pouch to 40 or 50 units. On account of the widely open Polya stoma, biliary and duodenal regurgitation were at times so marked as to depress gastric acidity even further. At this period, so little acid was discharged by the pouch that the dressings could be discarded and whatever digestion of the skin had been present before the operation quickly healed. After this interval however, gastric acidity began to increase steadily in all 5 dogs. The skin about the pouch began to break down again and careful daily neutralizing dressings had to be resumed. Within 4 to 6 weeks after the operation, maximum total acidities of 85 to 100 units were again obtained from the main stomach remnant, and 120 to 130 units from the pouch. The only final difference in the secretory curves obtained before and after resection and vagotomy was that in 3 dogs the highest acidities appeared 3 to 4 hours after the test meal was given, instead of after one to 2 hours. The injection of atropine caused about the same degree of temporary inhibition of gastric secretion as before gastrectomy and nerve di-

vision. Up to the present, 6 to 12 weeks after the resection-vagotomy operations, the return of hydrochloric acid to preoperative values has persisted in all of the animals except when an occasional biliary regurgitation modifies it (observed in 1 dog). In the main stomach or its remnant the amount of free hydrochloric acid in the contents after a test meal varied with the degree of neutralization by regurgitated intestinal fluids, and the amount of fixation of the acid radical by the protein in the meal and the protein in the mucus secreted by the gastric glands. On the other hand, in the pouch the secretion elicited after a test meal consisted nearly entirely of free hydrochloric acid, only a small amount being bound by the protein in the mucus.

The results of these experiments show that in the dog, subtotal gastrectomy combined with double infra-phrenic vagotomy induces only a temporary reduction in gastric acidity which is followed by a complete return of secretory function. Apparently the stomach is endowed with highly efficient compensatory mechanisms which provide for the continued production of hydrochloric acid under such conditions. The fact that the division of both vagi does not abolish the action of atropine indicates that the intrinsic postganglionic vagus mechanism remains intact.

6062

Further Studies on Continuous Secretion of the Pancreas.

T. F. ZUCKER, P. G. NEWBURGER AND B. N. BERG.

From the Department of Pathology, College of Physicians and Surgeons, Columbia University.

In a previous communication[1] observations were presented which indicate that in the dog pancreatic secretion is continuous during interdigestive periods, as it is in rabbits and ruminants. In another paper[2] we have discussed the inhibitory effect of ether anesthesia on continuous secretion, which explains the absence of continuous flow in the acute experiments of Bayliss and Starling. It has been claimed that continuous secretion in permanent fistulas is

[1] Berg, B. N., and Zucker, T. F., PROC. SOC. EXP. BIOL. AND MED., 1931, **28**, 724.

[2] Zucker, T. F., Newburger, P. G., and Berg, B. N., PROC. SOC. EXP. BIOL. AND MED., 1931, **29**, 294.