

for many adrenalectomies and also conserves material, since we and others^{2, 3} have found that it requires huge quantities of extract to keep adrenalectomized cats alive.

As yet a lack of uniformity in test animals must be encountered. An animal with an initial low carbon-dioxide capacity will show a greater reaction to the extracts than one injected when the carbon-dioxide capacity is high.

Forty-two adrenalectomized and 51 normal cats form the basis for this paper. Tests were repeatedly made on certain of these animals. Over 400 blood chemical determinations were made on the above animals. In studying the clinical symptoms of adrenal insufficiency over 200 animals were used.

5501

Continuous Pancreatic Secretion.

B. N. BERG AND T. F. ZUCKER.

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

The following study was undertaken in order to determine the characteristics of the flow of pancreatic juice in the fasting dog and the influence of certain stimuli upon the rate of pancreatic secretion. Cl. Bernard¹ and Pavlov² believed that pancreatic juice was secreted intermittently in response to specific stimuli. Continuous secretion was regarded by them as an abnormal response of the pancreas to irritation and inflammation. Farrell and Ivy³ found that pancreatic transplants secreted continuously in dogs. Recently Baxter⁴ reported that spontaneous pancreatic secretion occurred in rabbits under prolonged urethane anesthesia, after decerebration or decapitation, and after extirpation of the entire gastro-intestinal tract.

Permanent pancreatic fistulas were established in 4 dogs under ether anesthesia and with strict asepsis according to the technic de-

² Hartman, F. A., *Endocrinol.*, 1930, **14**, 229.

³ Swingle, W. W., and Piffner, J. J., *Science*, 1930, **71**, 321.

¹ Bernard, C., *Mémoire sur le pancréas*. 1856.

² Pavlov, I. P., *The work of the digestive glands*. London, C. Griffin and Co., 1910.

³ Farrell, J. I., and Ivy, A. C., *Am. J. Physiol.*, 1926, **78**, 325.

⁴ Baxter, S. G., *Am. J. Physiol.*, 1931, **96**, 343.

scribed by Elman and McCaughan.⁵ This method permitted a study of pancreatic secretion under relatively normal conditions. The pancreatic juice remained uncontaminated, the total output being collected and measured at 24 hour intervals. The animals were allowed to recover completely from the effects of the operation before observations were made. For the first 2 days after the establishment of the fistula, secretion was either absent or markedly diminished. The experiments were conducted 4 to 8 days after the onset of secretion. Autopsy examinations were negative. The pancreas showed no gross or microscopic evidences of inflammation or obstruction. The gastro-intestinal tract was found to be empty at the conclusion of the fasting experiments.

The rate of secretion was studied by the "drop method," 14 drops of pancreatic juice being equal to 1 cc. Observations were made at 1 minute intervals for 60 minute periods. The secretory pressure was determined by measuring the maximum height attained by the column of juice when the duct system was connected with a manometer 2 mm. in diameter. A column 100 mm. in height was equivalent to 0.7 cc. of pancreatic fluid. For practical purposes the manometric readings were interpreted as indicators of secretory pressure although it was recognized that there were factors in the secretory system, viz., elasticity of the duct walls, changes in vascularity of the pancreas, etc., which were probable sources of error. Since the conditions under which the experiments were performed remained relatively constant and since the difference between the pressure during fasting and during digestion was beyond normal variations, the determinations were considered significant.

Preliminary to the study of pancreatic secretion during fasting, the dogs were deprived of food and water for a minimal period of 24 hours. In order to avoid the possible influence of conditioned reflexes upon secretion, the animals were observed in a room where they were not accustomed to receive food. They were trained to lie quietly and often slept while the experiments were in progress.

The average rate of pancreatic secretion determined by the "drop method" in 2 fasting dogs was 2.8 drops per minute or approximately 12 cc. per hour. These figures coincided approximately with the hourly output of juice calculated upon a 24 hour basis, the total volume secreted per day varying between 250 cc. and 350 cc. The maximal secretory pressure in 2 fasting animals varied between 300 mm. and 340 mm. These levels were attained within periods of 12 minutes to 15 minutes.

⁵ Elman, E., and McCaughan, J. M., *J. Exp. Med.*, 1927, **45**, 561.

When 10 cc. of a solution of secretin⁶ was injected intravenously into a fasting dog, the flow of pancreatic juice was increased temporarily from an hourly rate of 2.8 drops per minute to 4 drops per minute. This acceleratory effect lasted 10 minutes⁷ and then the regular fasting rate of secretion was resumed. During digestion a prolonged acceleration occurred. Four hours after a meal consisting of meat the secretory pressure was 380 mm. in contrast to a previously fasting level of 300 mm.

Summary. Pancreatic secretion is continuous in fasting dogs. The rate of secretion is accelerated after the injection of secretin and during digestion. When the effects of these stimuli subside the flow of pancreatic juice continues.

5502

Action of Thyroxin on Tissue Metabolism.

ALEITA HOPPING. (Introduced by E. L. Scott.)

From the College of Physicians and Surgeons, Columbia University.

Magnus-Levy¹ showed that the thyroid gland increased metabolism. The manner in which this effect is brought about is still a matter for discussion.^{2, 3} Adler⁴ stated that thyroid action persisted after ergotamine and concluded a peripheral action. However, Abderhalden and Wertheimer⁵ found that ergotamine inhibited the effect of a previous thyroid injection. The great amount of work done on the direct effect of thyroxin on tissue metabolism has served to complicate rather than to clarify matters. Fleischmann,⁶ Rothschild,⁷ Simon,⁸ Paasch and Reinwein,⁹ Anselmino,¹⁰

⁶ Weaver, M. M., Luckhardt, A. B., and Koch, F. C., *J. Am. Med. Assn.*, 1926, **87**, 640.

⁷ Bayliss, W. M., and Starling, E. H., *J. Physiol.*, 1902, **28**, 325.

¹ Magnus-Levy, *Berl. klin. Wschr.*, 1895, **32**, 650.

² Plummer, *J. Am. Med. Assn.*, 1921, **77**, 243.

³ Kendall, *Tr. Ass. Am. Phys.*, 1918, 324; Kendall and Simonson, *J. Biol. Chem.*, 1928, **80**, 357.

⁴ Adler, cited by Reinwein, Helmuth and Singer, *Biochem. Z.*, 1928, **197**, 152.

⁵ Abderhalden and Wertheimer, *Pflüger's Arch.*, 1927, **216**, 697.

⁶ Fleischmann, *Biochem. Z.*, 1930, **187**, 324.

⁷ Rothschild, *Biochem. Z.*, 1930, **217**, 365.

⁸ Simon and Wiener, *Biochem. Z.*, 1929, **215**, 102.

⁹ Paasch and Reinwein, *Biochem. Z.*, 1929, **211**, 468.

¹⁰ Anselmino, Eichler and Schlossman, *Biochem. Z.*, 1929, **205**, 481.