perature of 2°-3° C.; (6) a temporary reduction in pulse rate, perhaps to 70 or 80, as compared with the normal values which ran between 120 at rest and 180-200 (or more) during excitement and struggling. Sometimes the drop in pulse rate was not very marked or was very transient. In other cases it was striking and maintained. Usually the rate subsequently increased and often became irregular. Occasionally there were extrasystoles. The pulse, whether fast or slow was full and bounding; (7) a blood pressure (femoral) sometimes showing a definite fall and subsequently a slight rise coincident with the pulse variations; (8) markedly constricted pupils which failed to react; (9) considerable prostration, apathy, nausea, and anorexia.

After a moderate dose of pilocarpine the effects would begin to wear off in less than an hour. The animal became more active (and less tractable) and evinced thirst and later hunger, and was normal again in a few hours.

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Comparative Frequency of Peptic Ulcers After Deprivation of Bile and Pancreatic Juice.

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Berg and Jobling[1] reported the occurrence of peptic ulcers in dogs following the deprivation of bile. These findings were corroborated by Kim and Ivy[2] and Bollman and Mann.[3] The incidence of ulcers was approximately 60%.

During the past few years, in connection with other investigations, we have examined a number of animals deprived of their pancreatic secretions by means of fistulas, ligation of the pancreatic ducts, and pancreatectomy, and have been impressed by the infrequent occurrence of peptic ulcers in these animals compared to dogs in which bile was excluded. On the other hand, Elman and Hartmann[4] found ulcers in the duodenum in all of the animals of a series of 6 dogs

[1] Berg, B. N., and Jobling, J. W., *Arch. Surg.*, 1930, **20**, 997.

[2] Kim, M. S., and Ivy, A. C., *J. Am. Med. Assn.*, 1931, **97**, 1511.

[3] Bollman, I., and Mann, F. C., *Arch. Surg.*, 1932, **24**, 126.

[4] Elman, R., and Hartmann, A. F., *Arch. Surg.* 1931, **23**, 1030.

with pancreatic fistulas existing from 13 days to 18 days. They described the lesions as ulcers, although microscopic examination revealed only defects in the continuity of the mucosa, not involving the deeper muscular layers of the intestine. These investigators attributed the lesions to the loss of the neutralizing effect of pancreatic juice upon gastric acidity, and minimized the importance of bile as a factor in the development of peptic ulcers in dogs.

The following observations were made upon a series of 14 dogs deprived completely of pancreatic juice by means of fistulas made according to the technique of Rous and McMaster, as adapted by Elman and McCaughan.[5] Twelve of the animals received sodium chloride by mouth or intravenously; 2 received no special form of treatment and were killed after 25 days and 31 days respectively. Some of the animals were killed while they were still in good condition. Others developed symptoms typical of pancreatic insufficiency[6] and died spontaneously. The average daily output of pancreatic juice varied between 200 cc. and 700 cc. in different animals.

In 11 dogs, with drainage existing for 14, 18, 20, 20, 20, 20, 25, 25, 31, 37, and 40 days respectively, no changes in duodenum or stomach were present at autopsy. In 2 animals, multiple small superficial mucosal erosions were found after 16 days and 20 days respectively. In one dog 2 perforated duodenal ulcers were found after 25 days.

The fact that ulcers were encountered in only one of 14 dogs with fistulas is particularly significant since a larger number of animals was included in this series than in the experiments of Elman and Hartmann, and the periods of drainage were longer. We have found that dogs with pancreatic fistulas may be kept alive for long periods of time by providing for a suitable adjustment of the electrolyte equilibrium by means of sodium chloride.[7]

A great deal of confusion exists concerning the interpretation of the results of different investigators, because no distinction is made between simple erosions and real peptic ulcers. We do not include mucosal erosions within the category of ulcers, because similar lesions are encountered in dogs under a variety of circumstances, *viz.*, excessive vomiting, severe intoxications, infections, uremia, poisoning, bilateral adrenalectomy, and as a terminal phenomenon. Until more is known concerning the etiology and development of ulcers, we

[5] Elman, R., and McCaughan, J. M., *J. Exp. Med.*, 1927, **45**, 561.

[6] Berg, B. N., and Zucker, T. F., PROC. SOC. EXP. BIOL. AND MED., 1931, **29**, 68.

[7] Zucker, T. F., Newburger, M. G., and Berg, B. N., PROC. SOC. EXP. BIOL. AND MED., 1930, **27**, 666.

believe that it is better, especially in experimental studies, to restrict the term ulcer to defects which involve one or more muscular layers as well as the mucosa, and correspond to the acute or chronic penetrating or perforating lesions that are encountered in man.

The dog in which ulcers were found was one of 3 animals which developed jaundice, and showed marked degenerative changes in the liver at autopsy. This finding coincides with our earlier observations concerning the possible rôle played by biliary and hepatic factors in the genesis of peptic ulcers in dogs.[1] The occurrence of degenerative alterations in the liver after the prolonged deprivation of pancreatic juice has been described.[6]

In double pancreatic duct ligations, followed by atrophy of the pancreas (5 dogs), no changes in the duodenum or stomach were found, 23, 47, 53, 80, and 97 days respectively, after ligation. Ivy and Fauley[8] encountered ulcers in 6 out of 61 animals after ligation of the pancreatic ducts. We have not observed ulcers in dogs after total pancreatectomy, and others who have studied insulin treated depancreatized dogs (fed raw pancreas) over periods as long as 2½ years have not reported the occurrence of ulcers.[9]

Conclusion. The preponderance of evidence indicates that peptic ulcers develop in dogs more readily after the deprivation of bile than after the loss of pancreatic juice.

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Gastrointestinal pH in Rats as Determined by the Glass Electrode.*

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Investigators have reported many studies on gastrointestinal pH in animals, using various methods of determination—hydrogen electrodes, quinhydrone electrode, and colorimetry. The results have all been somewhat open to question because of the possible inaccuracy of these methods in a medium such as intestinal contents. For the

[8] Ivy, A. C., and Fauley, G. B., *Am. J. Surg.*, 1931, **11**, 531.

[9] Best, C. H., and Hershey, J. M., *J. Physiol.*, 1932, **75**, 49. Chaikoff, I. L., Macleod, J. J., Simpson, W. W., and Markowitz, J., *Am. J. Physiol.*, 1926, **76**, 210.

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