5487

Alkalinity of Gastric Venous Blood During Gastric Secretion.

MARTIN E. HANKE, R. E. JOHANNESEN AND MAUDE M. HANKE.

From the Department of Physiological Chemistry, University of Chicago.

This study was undertaken to determine whether or not gastric HCl formation is accompanied by the simultaneous formation of an equivalent amount of alkali by the gastric tissue. The available alkali of gastric venous blood was compared with that of arterial blood simultaneously drawn during various conditions of gastric activity. The difference in available alkali in the 2 bloods is equal to the difference in bicarbonate (Δ $BHCO_3$ = $BHCO_3$ in gastric blood —$BHCO_3$ in arterial blood) plus the difference in alkali bound by protein (Δ BP) at constant pH. The $BHCO_3$ of the blood was calculated from Hasselbalch's equation, $pH = pK^1 + \log \frac{BHCO_3}{H_2CO_3}$, by substituting the values for pH and total CO_2 experimentally determined. In calculating the difference in base bound by proteins of the 2 bloods 3 proteins must be considered, proteins of serum, Ps, hemoglobin, Hb, and oxyhemoglobin HbO_2. $\Delta BP_{blood} = \Delta BPs + \Delta BHbO_2 + \Delta BHb$. The following equations were used for calculating each of these. Δ pH in any case is pH of gastric blood —pH of arterial blood.

$\Delta BPs = 3.4 \times \Delta$ pH serum.
$\Delta BHb = 3.35 \times$ mmols Hb $\times \Delta$ pH cells.
$\Delta BHbO_2 = 3.60 \times$ mmols $HbO_2 \times \Delta$ pH cells.

Because of their relatively small capacity for combining with base, the proteins of serum were not determined but were assumed to be constant, and the equation $\frac{dBPs}{d\ pH} = 3.4$ was assumed for all the samples of blood worked with. The pH of the cells, used in calculation of Δ BHb, and Δ $BHbO_2$ was obtained from the pH of the serum, using the figure of Van Slyke, Wu and McLean,[1] giving the relation of cell and serum pH's. The values for $\frac{d\ BHbO_2}{d\ pH}$, and $\frac{d\ BHb}{d\ pH}$, are also those of Van Slyke, Wu, and McLean.[2] Oxyhemoglobin was obtained from oxygen content, and total hemoglobin from oxygen capacity determinations. The experimental determinations on the blood included pH of serum (by quinhydrone electrode),[3] CO_2 con-

[1] Van Slyke, Wu, and McLean, *J. Biol. Chem.*, 1923, **56**, 778.

[2] Van Slyke, Wu, and McLean, *J. Biol. Chem.*, 1923, **56**, 811.

[3] Hanke, Martin E., PROC. SOC. EXP. BIOL. AND MED., 1930, **27**, 972.

tent, oxygen content, and oxygen capacity. The blood gas determinations were made in the manometric gas apparatus of Van Slyke and Neill.[4]

Control determinations were first made to determine with what accuracy the addition of known amounts of HCl or NaOH to blood would be reflected in changes in their $BHCO_3$ and BPr content. It was found that the addition of 3 or 4 millimols of HCl to normal dog or beef blood equilibriated with 40 mm. CO_2 plus air to one atmosphere, was quantitatively reflected in a decrease of $BHCO_3$ + BPr content with a maximum error of 0.3 millimol.

For the gastric secretion experiments large dogs under barbital anesthesia were used. Histamine, one or 2 mg. per dog, given intramuscularly, was used as gastric stimulant, which usually resulted after one hour in marked gastric secretion, 50 cc. per hour containing N/10 HCl being a typical response. The serous side of the stomach was exposed through an incision in the abdominal wall, and the gastric venous blood was collected from one of the gastric veins attached to the outside of the serous membrane. The arterial blood was drawn from the femoral artery as soon as possible, within 10 minutes, after the gastric blood was drawn. For the determination of pH, O_2 and CO_2 content, the blood was drawn in tubes under oil, to protect against changes in gas content. Gastric juice was collected by stomach tube at noted time intervals, its volume measured, and its acidity determined by titration.

TABLE I.
Arterial and Gastric Venous Blood.

Gastric Juice cc. per hour free acid	33 80		54 74		0 0	
	A_2	G_2	A_3	G_3	A_1	G_1
pH serum	7.19	7.26	7.27	7.36	7.40	7.43
mmols CO_2 blood	20.18	19.57	19.76	19.68	23.26	22.26
mmols HbO_2	8.53	8.72	8.04	7.55	8.22	9.84
mmols Hb	1.20	1.20	1.48	2.03	2.74	1.18
$BHCO_3$	18.53	18.16	18.40	18.56	22.15	21.27
Δ $BHCO_3$ (G-A)		—0.37		+0.16		—0.88
Δ BPr (G-A)		+2.26		+2.69		+0.89
Δ $BHCO_3$+Δ BPr (G-A)		+1.89		+2.85		+0.01

The table gives the result of a typical experiment. When there was no gastric secretion, the difference between arterial and gastric venous blood, in the base bound by bicarbonate and protein, was

[4] Van Slyke and Neill, *J. Biol. Chem.*, 1924, **61**, 523.

found in 3 experiments to be at most 0.6 millimol. During active gastric secretion this difference in 4 experiments was from 1.8 to 3.5 millimols. The magnitude of the difference was roughly proportional to the rate of gastric acid secretion.

These results show that gastric acid formation is accompanied by the simultaneous formation of an approximately equivalent amount of alkali by the gastric tissue.