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Relation of the Plasma and Whole Blood CO<sub>2</sub> in Cancer.

FRITZ BISCHOFF, ELSIE HILL AND M. LOUISA LONG.

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*From the Cancer Research Department of the Santa Barbara Cottage Hospital,  
Santa Barbara, California.*

Van Slyke and Sendroy<sup>1</sup> have worked out a line chart for estimating the factor by which whole blood [CO<sub>2</sub>] is multiplied to obtain plasma or serum [CO<sub>2</sub>]. This factor is dependent upon the pH, the oxygen capacity and the degree of saturation of the hemoglobin. In the majority of blood analyses presented by these authors, the difference between the observed and calculated value was not over 1 volume per cent. In the values calculated from the data of Peters, Bulger and Eisenman,<sup>2</sup> however, a greater deviation was observed. "The greater variability of these bloods was regarded as due to the fact that they were from a miscellaneous group of hospital patients, many of whom were obviously in very pathological condition."

In studies on the blood chemistry of a series of hopeless cancer patients we determined the data required to calculate the plasma [CO<sub>2</sub>] from the whole blood [CO<sub>2</sub>]. The plasma [CO<sub>2</sub>] was also determined. We are reporting the results because of the abnormal relationship between whole blood and plasma [CO<sub>2</sub>] observed in several instances.

The plasma pH was determined by means of the quinhydrone electrode, by a method (slightly modified) recommended by Cullen. The other data were determined by the Van Slyke-Neil manometric apparatus. We have included analyses of the bloods of several non-cancerous individuals. The plasma [CO<sub>2</sub>] of this group as calculated from the line chart falls well within the error found by Van Slyke and Sendroy. The greatest deviation between the observed and calculated plasma [CO<sub>2</sub>] is 1.2 volumes per cent.

The bloods of 11 hopeless cancer patients were studied. Of these the difference between the observed and calculated plasma [CO<sub>2</sub>] was abnormally large in 5 cases. In 4 cases the difference was equal to or greater than the 2.5 volume per cent difference found as the maximum difference in the Peters, Bulger, and Eisenman

<sup>1</sup> Van Slyke, D. D., and Sendroy, J., Jr., *J. Biol. Chem.*, 1928, lxxix, 781.

<sup>2</sup> Peters, J. P., Bulger, H. A., and Eisenman, H. J., *J. Biol. Chem.*, 1923, lviii, 773.

TABLE I.—Comparison of the plasma  $[\text{CO}_2]$  as calculated from the plasma pH, oxygen capacity and hemoglobin unsaturation, by the Van Slyke-Sendroy Line Chart and as experimentally determined for a group of normal and of cancer patients.

Name	Date	pH of plasma at body temp.	Determined		O <sub>2</sub> capacity vol. %	O <sub>2</sub> unsaturation %	[CO <sub>2</sub> ]p Calculated from Line Chart	Observed [CO <sub>2</sub> ]p—Calculated [CO <sub>2</sub> ]p
			[CO <sub>2</sub> ]p in plasma vol. %	[CO <sub>2</sub> ]b in whole blood vol. %				
B. T.	5/14/29	7.43	64.2	51.6	24.0	52	64.2	0.0
B. M.	3/29/29	7.45	69.7	57.6	22.0	67	70.0	-0.3
E. O.	8/24/29	7.50	64.3	54.5	19.4	48	65.5	-1.2
W.	8/24/29	7.49	67.2	53.7	22.4	35	67.3	-0.1
W. A.	8/ 8/29	7.50	65.5	53.4	20.5	41	65.4	+0.1
L.	8/25/29	7.45	65.6	51.4	23.4	32	64.4	+1.2
C.	8/ 8/29	7.45	62.0	49.9	21.2	33	61.1	+0.9
G.	5/25/29	7.52	64.7	54.0	17.4	37	64.2	+0.5
	5/30/29	7.56	60.1	48.7	17.8	4	59.3	+0.8
	6/21/29	7.51	61.8	51.8	18.7	26	62.6	+0.8
C.	6/26/29	7.44	82.2	66.9	18.6	55	79.1	+3.1
	7/ 3/29	7.51	80.0	66.7	16.2	36.5	78.1	+1.9
Mc.	10/ 8/29	7.46	68.3	54.0	18.9	10	65.1	+3.2
	11/ 7/29	7.47	68.9	55.7	18.6	60	66.0	+2.9
A.	10/17/29	7.52	62.3	54.2	18.5	52	64.8	-2.5
	11/17/29	7.52	63.4	55.9	15.0	59	64.3	-0.9
C.	6/ 7/29	7.49	60.2	54.4	9.9	27	59.4	+0.8
M.	9/10/29	7.58	56.0	50.6	8.6	23	55.1	+0.9
McK.	8/21/29	7.57	64.2	56.4	12.7	33	64.3	-0.1
Ma.	10/10/29	7.45	61.8	53.4	13.2	31	60.5	+1.3
T.	10/14/29	7.54	64.1	58.2	11.6	50	65.0	-0.9
L.	10/26/29	7.53	65.0	54.6	21.7	40	68.0	-3.0
G.	10/29/29	7.51	60.7	52.1	19.6	29	63.4	-2.7

\* Blood taken during heating experiment, in which body temperature was raised by high frequency electric current. In this experiment the body temperature was raised from 36.6 C. to 37.2 C. The plasma pH rose from 7.48 to 7.56. The plasma  $[\text{CO}_2]$  fell from 66.0 to 60.1.

† Patient had vomited before the blood was drawn. The symbols are those used by Van Slyke and Sendroy.

data. For 3 cases in which the difference was abnormally high, the data were determined again at a later date. In 2 of these, the difference remained abnormal. In the third, the last result was normal. It is interesting to note that this patient received radium and colloidal lead phosphate after the determination of the first data and had shown a marked improvement. The observed value was higher than the calculated in 2 instances of those which showed a maximum deviation. In 3 instances it was lower. These 3 cases all had carcinoma of the cervix. This observation may be entirely fortuitous. Abnormal albumin and globulin contents of blood have been observed in cancer patients.<sup>3</sup> It is probable that an abnormal serum protein content or distribution is responsible for the abnormal results obtained in our series. For 7 of the cancer patients the difference between the calculated and observed plasma [CO<sub>2</sub>] was no greater than for the normal group. It should be noted that several of these patients were very anemic.

*Summary:* In calculating the plasma [CO<sub>2</sub>] of blood from cancer patients by the Van Slyke line chart, an error of 2 to 3 volumes per cent may be introduced. Of 11 cases studied, 6 observed values showed a normal agreement with calculated values. Of the 5 values which showed an abnormal deviation, 2 were in one direction and 3 in another.

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**Egg-Laying in *Triturus Viridescens* Following Pituitary Transplants.**

A. ELIZABETH ADAMS.

*From the Department of Zoology, Mount Holyoke College, South Hadley, Mass.*

From the work of Smith,<sup>1</sup> Smith and Engle,<sup>2</sup> and Engle<sup>3</sup> it is known that anterior pituitary transplants hasten sexual maturity in rats and mice. In females the ovaries contain an excessive number of mature follicles and superovulation occurs. Egg-laying, mating, and subsequent development of the fertilized eggs has also been induced in frogs, in autumn, by Wolf.<sup>4</sup>

<sup>3</sup> Wells, H. G., "Chemical Pathology," W. B. Saunders Company, 1925, 572.

<sup>1</sup> Smith, P. E., *Anat. Rec.*, 1926, xxxii, 221; *PROC. SOC. EXP. BIOL. AND MED.*, 1926, xxiv, 131.

<sup>2</sup> Smith, P. E., and Engle, E. T., *Am. J. Anat.*, 1927, xl, 159.

<sup>3</sup> Engle, E. T., *Anat. Rec.*, 1928, xxxvii, 275.

<sup>4</sup> Wolf, O., *PROC. SOC. EXP. BIOL. AND MED.*, 1929, xxvi, 692; *Anat. Rec.*, 1929, xlv, 206.