

Changes in Cerebral Blood Flow and Arterio-Venous Oxygen Difference During Insulin Hypoglycemia.*

H. E. HIMWICH, K. M. BOWMAN, C. DALY, J. F. FAZEKAS,
J. WORTIS AND W. GOLDFARB.

From the Department of Physiology and Pharmacology, Albany Medical College, Union University, Albany, N. Y., and Psychiatric Division, Bellevue Hospital, New York City.

Previous work has disclosed that the arterio-venous oxygen difference of cerebral blood is diminished during insulin hypoglycemia.^{1, 2} However, the arterio-venous oxygen difference is determined not only by the metabolic rate of the brain, but also by velocity of blood flow. Therefore, the possibility exists that the smaller oxygen difference found may be due to a more rapid blood flow during hypoglycemia. Observations by Loman and Myerson³ on human subjects and Leibel and Hall⁴ on rabbits, have failed to demonstrate any marked changes in the rate of cerebral blood flow during insulin hypoglycemia uncomplicated by convulsions. However, for conclusive information regarding changes of brain metabolism, it is necessary to determine, simultaneously, the cerebral blood flow and the arterio-venous oxygen difference. The results of such a study on patients with schizophrenia are presented in this preliminary report.

Methods for the collection and analysis of the blood samples have been previously described.² The rate of blood flow in the internal jugular vein was estimated by a modification of the Gibbs thermostromuhr. This instrument proved to be at least as sensitive as the original and will be described elsewhere. Observations on the blood flow were made over long periods during which the position of the thermostromuhr in the vein was maintained constant. A special technique was devised which prevented error resulting from the formation of clots on the needle.

In 5 cases the blood flow and the arterio-venous differences were determined before injection of insulin as well as throughout the

* Aided by a grant from the Child Neurology Research (Friedsam Foundation).

¹ Dameshek, W., Myerson, A., and Stephenson, C., *Arch. Neurol. and Psychiat.*, 1935, **33**, 1.

² Himwich, H. E., Bowman, K. M., Wortis, J., and Fazekas, J. F., *J. Nerv. and Ment. Dis.*, 1939, **89**, 273.

³ Loman, J., and Myerson, A., *Am. J. Psychiat.*, 1936, **92**, 791.

⁴ Leibel, B. S., and Hall, G. E., *Proc. Soc. Exp. Biol. and Med.*, 1938, **38**, 894.

TABLE I.
Arterio-Venous Oxygen Differences and Cerebral Blood Flow During Insulin Hypoglycemia.

Patient	Glucose Art.	Oxygen			Observed change of blood flow %	Calculated* change of blood flow %
		Art.	Ven.	Diff.		
1	83	17.11	10.97	6.14		
	19	17.35	13.28	4.07	-10	+ 51
	15	17.83	15.67	2.16	-30	+184
	17	17.63	15.30	2.33	-10	+168
	13	17.52	16.18	1.34	0	+358
2	34	16.47	14.93	1.54		
	117	16.62	11.30	5.32	-20	-246

*Calculated from A:V oxygen difference if brain metabolism is unchanged.

course of the coma and the subsequent administration of glucose. In 3 other instances the observations were begun during coma and continued until after arousal with intravenous glucose. The data observed in one of each of these 2 types of experiments are presented in the table. In none of these experiments could the low arterio-venous difference during hypoglycemia be accounted for by any change in blood flow, and in most cases the changes in blood flow were opposite in direction, showing a slow blood flow with a low arterio-venous difference.

Thus, the decreased arterio-venous difference of oxygen cannot be attributed to a more rapid blood flow, but must be due to a diminished brain metabolism. These results are in accordance with the conception that the chief fuel of the brain is glucose.² The fact that the cerebral respiratory quotient is unity;⁵ that glucose awakens patients from hypoglycemic coma; and that the alpha waves of the electroencephalograph disappear in hypoglycemia and reappear after the administration of glucose^{6, 7} all indicate the importance of glucose in brain metabolism.

⁵ Himwich, H. E., and Nahum, L. H., *Am. J. Physiol.*, 1932, **101**, 446.

⁶ Hoagland, H., Rubin, M. A., and Cameron, D. E., *Am. J. Physiol.*, 1937, **120**, 559.

⁷ Himwich, H. E., Hadidian, Z., Fazekas, J. F., and Hoagland, H., *Am. J. Physiol.*, 1939, **125**, 578.