

ABNORMAL HEMOGLOBINS. IV. AN ANALYSIS OF MORE THAN 9000 PATIENTS*

WILLIAM F. McCORMICK, M. D.**

*Department of Pathology, University of Tennessee and the City of Memphis Hospitals
Memphis, Tennessee*

Several years ago I published the results of a continuing study of the incidence of the abnormal human hemoglobins in the Memphis and Western Tennessee Region (1). This study terminated on July 1 of this year (1964) and can now be reported in final form in this brief communication.

METHODS AND MATERIALS

Blood was obtained from blood bank donors of the City of Memphis Hospitals, from in-patients of the West Tennessee Tuberculosis Hospital, from the Western State Hospital at Bolivar, and from both in- and out-patients of the City of Memphis Hospitals. These four sources make up the "clinical" material, which was used for comparison with autopsy samples obtained from the City of Memphis Hospitals—University of Tennessee autopsy service.

Five to 10 ml of blood were collected in potassium-ammonium oxalate and refrigerated at 4 C until used, usually within 24 hr. The blood was then centrifuged at 1500 X g for 15 min. and the plasma removed. The packed red blood cells were then washed 3 times with 0.9 per cent saline solution to remove all serum proteins. After the final wash, the packed red cells were lysed with 1.5 volumes of distilled water and 0.5 volume of toluene, centrifuged to remove the stromal elements, and filtered through Whatman No. 3 filter paper.

An aliquot of each whole blood sample was mixed with sodium metabisulfite in order to test for the sickling phenomenon.

Aliquots of the hemolysates were subjected to alkali denaturation to determine the percentage of fetal hemoglobin, and to electrophoresis on paper in Veronal buffer at pH 8.6, 0.06 M. For the electrophoresis we used both the Spinco Model R electrophoresis system and our modification of the horizontal plate technic, using Whatman No. 3 MM filter paper strips, with a Heath kit power supply.

In the case of autopsy specimens, multiple (usually 30) sections of tissue were removed, fixed in 10 per cent neutral formalin, embedded in paraffin, sectioned at 6 microns, and stained with hemotoxylin and eosin. These slides were examined for the presence and also the degree of sickling.

The entire study population consisted of 9165 pa-

tients, of whom a total of 8050 were over one month of age.

The criteria for the diagnosis of the various abnormal hemoglobins states have been given by me before, and need not be repeated (1-3). The stability and usability of autopsy blood samples for hemoglobin electrophoresis have also been analysed and reported previously (3). Typical electrophoretic separations obtained for the major hemoglobin types are shown in Fig. 1.

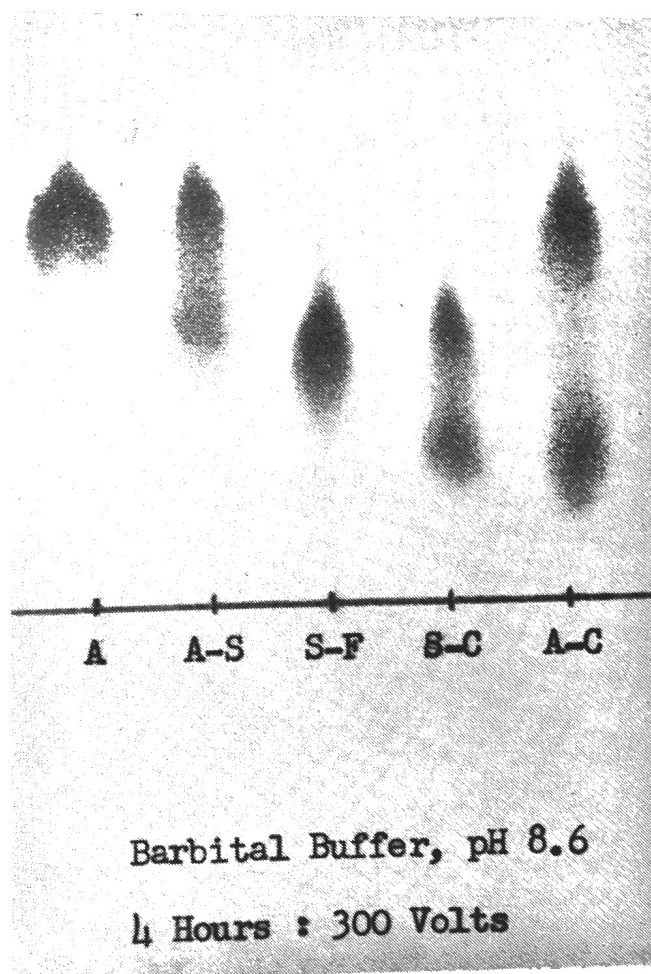


Fig. 1. Typical electrophoretic separation of hemoglobins A, S, F, and C as obtained in this study.

RESULTS

Tables 1-3 summarize the results of this study and are so complete as to need no further explanation. The number of patients examined is sufficiently large to have real statistical significance.

One white patient (A63-749) was found to have a

*This work was supported in part by U. S. Public Health Service grants No. A-2313-C1, and GM-09658-02, Department of Health, Education, and Welfare.

**Present address: Department of Pathology, University of Iowa, Iowa City, Iowa.

Table 1
Incidence of Hemoglobin S in Memphis and Western Tennessee*

Source	Race	Total No. Examined	Hemoglobin S Combinations				Total
			A-S	S-S	S-Thal.	S-C	
Autopsies	White	900	0	0	0	0	0
	Negro	3275	305(9.3%)	24(0.7%)	3(0.09%)	5(0.15%)	337(10.3%)
Clinical*	White	1596	0	0	0	0	0
	Negro	2279	178(7.8%)	10(0.4%)	0	2	190(8.3%)
Totals	White	2496	0	0	0	0	0
	Negro	5554	483(8.7%)	34(0.6%)	3	7(0.12%)	527(9.5

*The clinical material comes from the John Gaston Hospital out-patients and in-patients, West Tennessee Tuberculosis Hospital in-patients, Western State Hospital in-patients, and City of Memphis Hospitals blood

bank donors. All patients were over 1 month of age. This study covers the 6 1/2 calendar years from October, 1957 to July, 1964.

Table 2

Autopsy Blood Collection—University of Tennessee
October, 1957, to July, 1964

Year	Total Number of Autopsies	Total No. of Samples Collected	Per Cent Collected	Negroes 1 Mo.	Whites 1 Mo.
1957 (3 Mo.)	255	141	55.3	84	21
1958	1297	614	47.2	442	101
1959	1140	908	79.9	530	166
1960	1085	766	70.6	400	137
1961	1155	585	50.6	391	88
1962	1263	923	73.0	573	168
1963	1289	884	68.6	551	147
1964 (6 Mo.)	639	469	73.4	304	72
Totals	8126	5290	65.1	3275	900

There were 1115 samples collected from infants less than one month of age.

"fast" hemoglobin in association with hemoglobin A. (Figs. 2-3). Unfortunately, this patient had no living relatives, so that a family study could not be done. Moreover, there was insufficient blood obtained at

Table 3

Abnormal Hemoglobins Found at Autopsy
October, 1957 to July, 1964
—3275 "Adult" Negroes—

Hgb. Type	Number	Per Cent of Total
A-S	305	9.3
S-S	24	0.73
S-C	5	0.15
S-thal.	3	0.09
A-C	75	2.3
A-D	2	0.06
F-C	1	0.03
"Fast"	1	0.03
Total S	337	10.3
Total C	81	2.5
Total Abnormal	416	12.7

There were 7123 autopsies during the 81 month period, from which 5290 samples were collected (65%). Of these 5290 autopsies, 900 were "adult" white patients and 1115 were infants less than one month of age.

autopsy to make a definitive diagnosis of the hemoglobin type. It is quite likely either hemoglobin K or J.

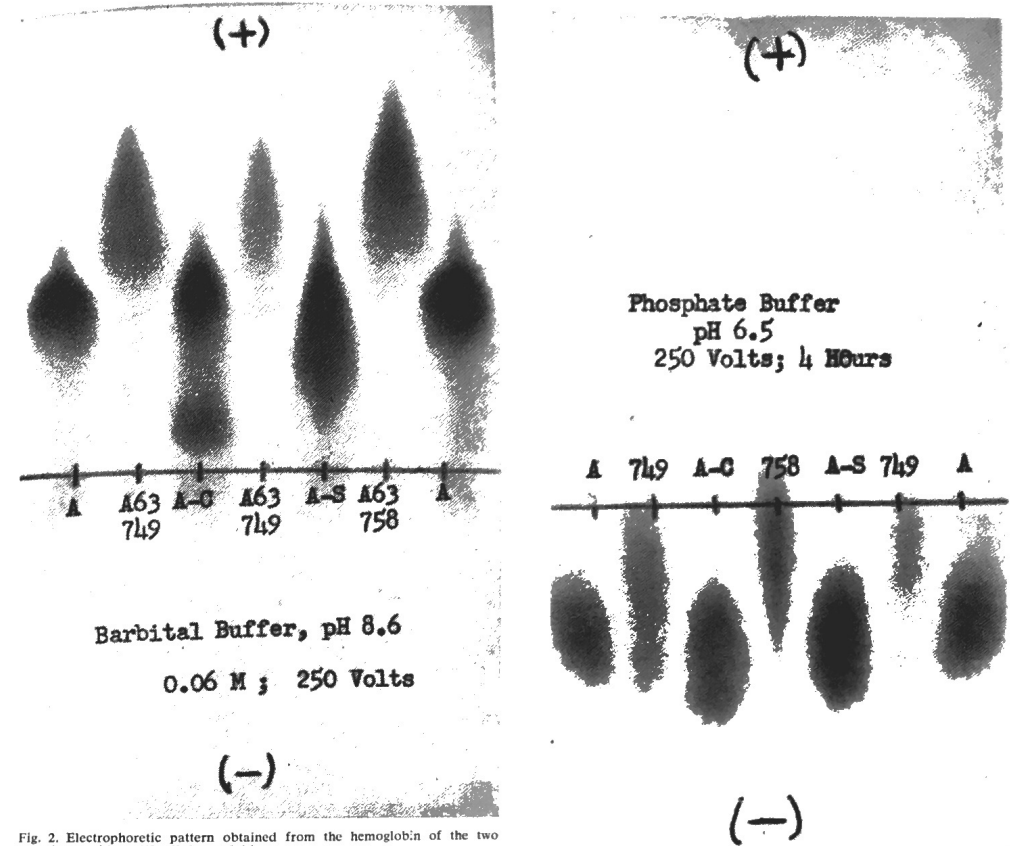


Fig. 2. Electrophoretic pattern obtained from the hemoglobin of the two patients with a "fast" hemoglobin.

DISCUSSION

There are several factors which may influence the results of such a study as this. Some of them, such as the accuracy of diagnosis and total number of patients examined, are sufficiently well controlled as to present no problems of interpretation. The major difficulty in deriving accurate incidence figures lies in the selection of patients for study. The virtual absence of abnormal hemoglobins in our nearly 2500 Whites is without doubt a true picture of that section of the population. (The single abnormal hemoglobin found in our White population has been illustrated above.) The same certainly can not be had for the Negro population. The overall incidence of abnormal types is probably in the range of 12-13 per cent, as noted in Table 3. The "fast" hemoglobin found in an autopsied Negro patient (A63-758) was apparently identical to the "fast" hemoglobin found in the White patient. It is illustrated in Figs. 2-3.

SUMMARY

The use of either autopsy or hospital patient speci-

Fig. 3. Same samples run in an acid medium. The non-homogeneity of the two "fast" hemoglobins (A63-749 and A63-758) are clearly evident.

mens for a "population" study is obviously not without bias, and no claim is made that the incidence figures given in this paper are exact. They do represent the best available data to date.

Abnormal hemoglobins are very largely, but not exclusively, found in Negroes. In all combinations, they are found in about one-eighth of the Negro population in Western Tennessee.

LITERATURE CITED

- McCormick, W. F. 1960, Abnormal Hemoglobins. I. Incidence in Memphis and Western Tennessee, with Special Reference to Autopsy Material, *Am. J. Clin. Path.* 34:220-224.
- McCormick, W. F. 1961, Abnormal Hemoglobins, III. The Pathology of Sickle Cell Trait, *Am. J. Med. Sc.* 241:329-335.
- McCormick, W. F. 1962, Abnormal Hemoglobins. III. The Stability of Non-Sterile Whole Blood for Electrophoretic Analysis, *Am. J. Clin. Path.*, 37:140-142.

BOOK REVIEW

FREDERICK T. WOLF

Department of Biology, Vanderbilt University, Nashville, Tennessee

Trees, Shrubs, and Woody Vines of Great Smoky Mountains National Park. Arthur Stupka. 186 pp. University of Tennessee Press, 1964.

This little volume is the product of 29 years experience of the author as naturalist and biologist of the Great Smoky Mountains National Park. In an introductory chapter are presented an historical account of botanical explorations of the area, the sources consulted, and the location of herbarium specimens of earlier collectors. The systematic account distinguishes the 200 or so native woody species, and those which

have been introduced. The data presented includes altitudinal distribution and blooming dates. While this book is "not intended to serve as a means of identifying the species of woody plants in the park," there are separate keys to the trees, shrubs, and woody vines.

Of special interest to this reviewer were the data concerning sizes of the largest trees of several species within the park, including such giants as a yellow poplar 23 feet 7 inches in circumference, a hemlock with a circumference of 19 feet 10 inches, and a cucumber tree measuring 18 feet 4 inches around.

NEWS OF TENNESSEE SCIENCE*(continued from Page 141)*

A three-day symposium on electrophilic aromatic substitution was held at Vanderbilt University in August. The symposium was in honor of Sir Christopher K. Ingold of the University College of London, the National Science Foundation Senior Scientist at Vanderbilt.

In addition to Sir Christopher, the speakers were Dr. George Olah of the Dow Chemical Co.; Dr. John Riss, also of University College, London; Dr. Peter Kovacic, Case Institute of Technology, Cleveland, Ohio; Dr. Leon M. Stock, University of Chicago; and Dr. Donald E. Pearson, Professor of Chemistry at Vanderbilt.

Three Tennessee physicists have been elected to top posts in the Southeastern Section of the American Physical Society. Dr. Richard D. Present of the University of Tennessee has been named chairman; Dr. Ernest Jones of Vanderbilt University, vice chairman, and Dr. Myron S. McCay of the University of Chattanooga, re-elected treasurer. Dr. Howard E. Carr of Auburn University was re-elected secretary.

The group, which meets next year in Charlottesville, Va., voted to meet in 1966 at Vanderbilt University. This year's meeting was Nov. 5-7 at the University of Chattanooga.

A new major in geology has been approved for East Tennessee State University and is under the direction of Robert W. Darling, Associate Professor. Lymon O. Williams has joined the Department of Geography and Geology as assistant professor of geology.

Other new members of the science faculties at ETSU include Wallace A. Tarpley, Assistant Professor of Biology, Robert R. Ralston, Associate Professor of Chemistry, Robert Ling, Assistant Professor of Mathematics, and Herbert C. Armentrout, Instructor in General Science.

The School of Medicine at Vanderbilt University has made a sweeping revision of its curriculum, designed to grant students greater responsibility for their medical education.

The required courses have been reorganized, an adviser system has been introduced, and the school has shifted almost completely to the semester system used by the other schools of the University. But perhaps the most striking development is the formal introduction of about 150 new elective courses.

Seniors will benefit most from the new course of study, which marks the most comprehensive curriculum change in the 90-year history of the medical school. The senior may now spend up to 70 per cent of his time in electives. These include lecture courses, clinical clerkships on the wards, and fellowships—or he may even go to other institutions for fellowships or clerkships. The senior may also take non-medical graduate or undergraduate courses in other schools at Vanderbilt.

Two Vanderbilt University researchers have reported to the American College of Physicians on a unique study which they have been carrying on in the field of medical ethics. They are Dr. Elliot V. Newman, Director of the Clinical Research Center at the Vanderbilt Medical Center, and Samuel E. Stumpf, Chairman of Vanderbilt's Philosophy Department. Dr. Newman is also Joe and Morris Werthan Professor of Experimental Medicine at Vanderbilt.

Since 1962, the philosopher has regularly donned a white lab coat and made hospital rounds with Dr. Newman. The two have dealt with the medicomoral problems of human experimentation, organ donorship and aging, and on to all the myriad questions raised by the moral, social and legal implications of modern medical science in general. They are continuing their research and hope soon to publish some of their findings.