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THE RELIABILITY OF THE COPPER SULFATE TEST AS A TEST
FOR ANEMIA

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The reliability of the copper sulfate test as an index of the specific gravity of the blood will be demonstrated. This test will be compared with three other simultaneously performed tests for anemia. These three tests are: the hematocrit (packed cell volume); the Sahli test; and the photoelectric colorimeter test.

The copper sulfate test is a relatively simple test that can be performed by a person with no technical training. All that is needed to perform the test are: the copper sulfate solution, and a means for collecting a drop of venous or capillary blood. The outcome of the test depends on the rise or fall of a drop of whole blood in a copper sulfate solution of selected specific gravity. By using one solution of a selected specific gravity, the anemic can be screened from the non anemic. By employing a system of graded solutions, one can obtain a more quantitative result. The author proposes that the great usefulness of the test will be as a rapid screening test. The details of the copper sulfate test may be found elsewhere. (1) Because of the alteration of the specific gravity of the blood in pregnancy a question has been raised as to the dependability of the test. In the non-pregnant patient the accuracy of the test has been assured.

Ham has pointed out the inconsonance of hematological results. (2) Using twenty medical students with considerable training, a specimen of blood was given ten different examinations. It was found that the error in the hematocrit and photoelectric cell colorimeter was small, because of the small chance of objective and subjective errors. But the Sahli and other techniques compared unfavorably. The red cell count fared so badly that it could not be used as a routine screening procedure for anemia.

In the project undertaken by the author, an attempt was made to test, by Sahli, photoelectric colorimeter, hematocrit, and copper sulfate, all the women attending the pre-natal clinic and the obstetrical service of the University of Nebraska College of Medicine. In these patients the month of pregnancy was 32 weeks or more. The project was completed in four months. All four tests were performed on a specimen of venous blood obtained either at the pre-natal clinic or in the obstetrical service before delivery. There were 111 women screened, but because of standardization failures, errors in drawing blood, and equipment failures the tests were reported on 93 women.

Several standards have been suggested for deciding what values shall be used in deciding who is anemic

in pregnancy. Some clinics employ the hematocrit value of 30%, others 31% and 32%. In my study it was recommended by the Department of Obstetrics and Gynecology that the value of 33% should be the least acceptable normal reading. It was also decided to use the hemoglobin value of 10 grams per 100 cc. of blood or less as constituting an anemia. The value of a specific gravity of 1.047 would constitute an anemia of pregnancy. No allowance will be made for the decrease in plasma volume in the last few weeks of pregnancy

Table I shows the distribution of all the 93 cases by hematocrit and compares them with the copper sulfate, colorimeter and Sahli readings. Unfortunately the classification of a patient as anemic seems to depend on the choice of a test. By the colorimeter; 23 patients (24.8%) were anemic, by Sahli 20 patients (21.1%), and by the copper sulfate test 22 patients (23.6%). Stating the confusion in another way, the copper sulfate found 8 women not anemic by Sahli, and Sahli found 6 women not anemic by photoelectric colorimeter determinations.

TABLE I DISTRIBUTION OF 93 NORMAL AND ANEMIC WOMEN BY FOUR TESTS

	COPPER SULFATE							
	ANEMIC COLORIMETER				ANEMIC COLORIMETER			
	ANEMIC SAHLI		ANEMIC SAHLI		ANEMIC SAHLI		ANEMIC SAHLI	
	ANEMIC	NORMAL	ANEMIC	NORMAL	ANEMIC	NORMAL	ANEMIC	NORMAL
	PCV 33% or more	9	4	3	3	1	6	4
32%								
31%								
30%	3							

The number found anemic by the hematocrit varied with the level chosen. Under 33% hematocrit there were 20 patients (21.5%); under 32% there were 8 patients (8.6%); under 31% there were 3 patients (3.2%); and under 30% these same three patients.

Using 33% hematocrit as the minimum accepted level, 11 women were anemic by all four tests, 2 women by 3 tests, 10 women by 2 tests, and 15 women by 1 test. If 30% hematocrit had been used only 3 women would have been anemic by all four tests

These comparisons of various levels of hematocrit and three hemoglobin screening tests place some doubt on the validity of considering 3% hematocrit acceptable in pregnancy as is the practice in some clinics. The anemia portions of the columns in Fig. 1 seem to indicate

that the use of 33% hematoerit as a critical figure is closer to the usual concept of what would constitute an anemia in pregnancy.

PERCENT FOUND ANEMIC BY VARIOUS TESTS AND STANDARDS

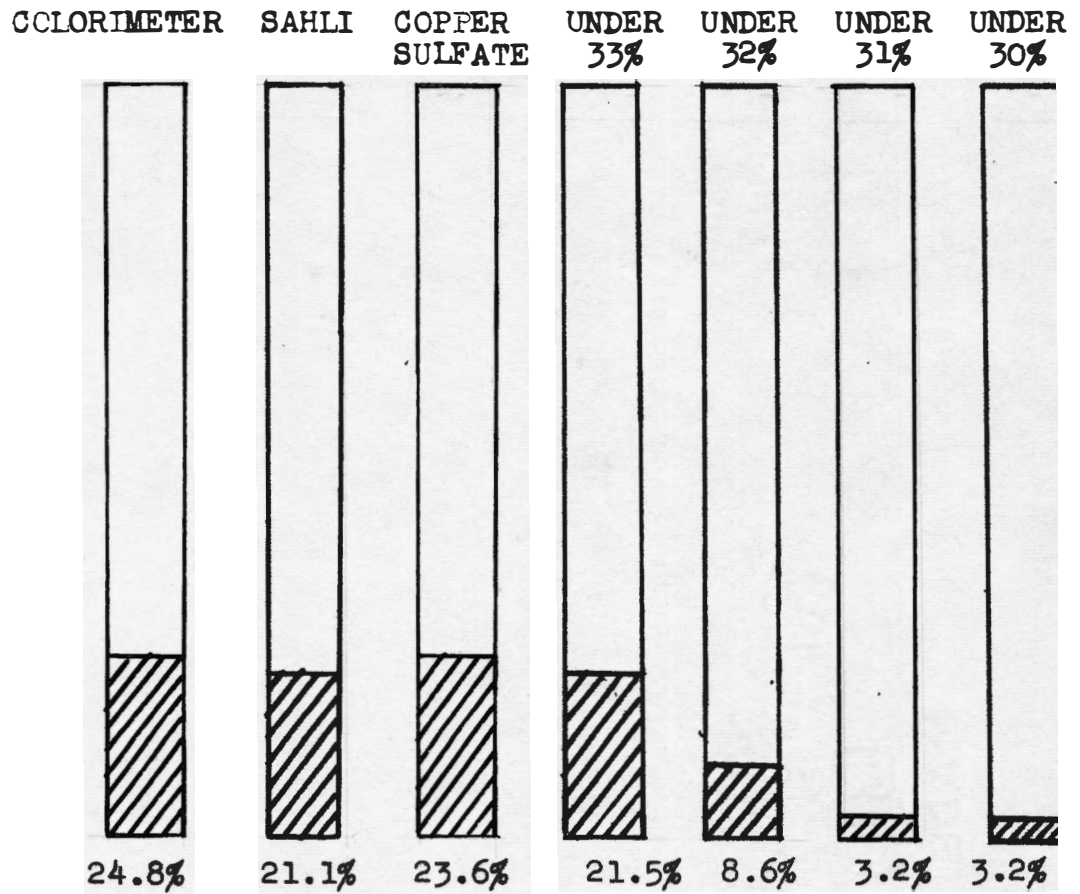


Fig. 1

The copper sulfate test appears to be a comparatively rough test if simplicity and roughness are similar. The following findings seem to establish the copper sulfate method as a satisfactory screening test in pregnancy.

1. 33% hematocrit as a minimum normal is used for the standard, and it is found there were 20 women with anemia, and the copper sulfate test missed 7 of them, but of these 7, 5 were not anemic by any other test and 2 were 9.9 grams/100 cc. of blood and 9.6 grams/100 cc. of blood which are borderline cases. The photoelectric colorimeter also missed 5 cases.
2. Using the colorimeter as standard, 23 women were anemic. The copper sulfate test missed 7 of these cases, but of these 7 only 2 have hematocrits below 33%. (both cases were 32%)
3. Viewed from the false anemic side, there were 9 cases that the copper sulfate test designated as anemic and in which the hematocrit was 33% or better, but 7 of these cases had hemoglobin values below 10.1 grams/100 cc. of blood. (All were 10 grams/100 cc. of blood or below)
4. The results with hematocrit and colorimeter, the two tests with reputations for reliability are compared in Table II below. 62 women were not anemic by both

tests, and 14 were anemic by both tests, making 76 in agreement, and 81.7% agreement. In Table III below comparing copper sulfate and colorimeter tests 78 are in agreement, an 83.8% agreement. Table IV compares the copper sulfate test with the hematocrit (33%), and finds 76 patients in agreement or 81.7%. Thus there is greater agreement in the copper sulfate colorimeter tests than the hematocrit colorimeter tests, and the same agreement between the copper sulfate hematocrit and the hematocrit colorimeter tests. Because of the high confidence that can be placed in both the colorimeter and hematocrit and the favorable comparisons that have been made here, I agree with Ferguson that the copper sulfate tests appear to be of at least comparable reliability. (3,4) Ferguson found in his comparisons a greater agreement in both the copper sulfate hematocrit and copper sulfate colorimeter, than between the hematocrit colorimeter tests.

TABLE II. COMPARISON OF THE HEMATOCRIT AND COLORIMETER TESTS

COLORIMETER	HEMATOCRIT	
	33%	<33%
Normal	62	9
Anemic	9	14

TABLE III. COMPARISON OF COPPER SULFATE AND COLORIMETER TESTS

COPPER SULFATE	COLORIMETER	
	NORMAL	ANEMIC
Normal	62	7
Anemic	6	16

TABLE IV. COMPARISON OF COPPER SULFATE AND HEMATOCRIT TESTS

COPPER SULFATE	HEMATOCRIT	
	33%	< 33%
Normal	63	1
Anemic	9	13

Summary

The author has undertaken to study the reliability of the copper sulfate falling drop test as a test for the anemias of pregnancy. The project consisted of a study of the different tests performed on whole blood for the purpose of determining whether or not a patient is anemic. Four different tests were compared in this paper. They were: the copper sulfate test; the Sahli hemoglobin test; the photoelectric colorimeter test; and the hematocrit. These four tests were run on 93 pregnant women who were being seen in the outpatient clinic and hospital of the College of Medicine, University of Nebraska. The reliability of the copper sulfate test was found to be accurate enough to permit such a test to be used as a screening test for the anemias of pregnancy.

Conclusions

The copper sulfate falling drop test for anemia compares favorably in accuracy with the hematocrit and photoelectric cell colorimeter tests and is recommended for the screening of pregnant women. The copper sulfate, hematocrit, Sahli, and colorimeter tests differ considerably in their sensitivity as screening tests.

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