

**CLINICAL SCREENING: A COST-EFFECTIVE
SCREENING TOOL FOR SEVERE ANEMIA IN
PREGNANT WOMEN**

TECHNICAL WORKING PAPER #7

**Erin Dusch, MotherCare/Washington
Rae Galloway, MotherCare/Washington
Endang Achadi, MotherCare/Indonesia
Idrus Jus'at, MotherCare/Indonesia
Chakunja Sibale, Project HOPE/Malawi
Ciro Franco, Project HOPE/Malawi
Simon Cousens, London School of Hygiene & Tropical Medicine
Linda Williams, London School of Hygiene & Tropical Medicine**

TABLE OF CONTENTS

<i>INTRODUCTION</i>	5
<i>METHODS</i>	6
<i>RESULTS</i>	6
<i>Developing Country Setting</i>	7
Children under 5 years of age	7
No description of study population	7
Men and Women	8
Adolescents and Adults (men and women over 12 years of age)	8
Men, Women and Children	8
Women	9
Men	9
<i>Western Country Setting</i>	10
Men and Women	10
Men	10
<i>DISCUSSION</i>	11
<i>Table 1: Pallor Studies in Developing Countries</i>	15
<i>Hemoglobin</i>	15
<i>Table 2: Pallor Studies in Western Countries</i>	17
<i>REFERENCES</i>	19

INTRODUCTION

Iron deficiency and iron deficiency anemia, as measured by low hemoglobin, are the most prevalent nutritional deficiencies in the world. Anemia is the most serious manifestation of iron deficiency, and it is estimated that for every individual with anemia there is at least one other person with iron deficiency.⁽¹⁾ Women of reproductive age and small children are at greatest risk of suffering from anemia, with an estimated 50 to 60% of pregnant women and 40% of small children suffering from it.⁽²⁻⁴⁾ Anemia during pregnancy is a major health concern; it has been associated with increased risk of maternal morbidity,⁽⁵⁾ maternal mortality,⁽⁶⁻⁹⁾ and poor birth outcomes including stillbirth, prematurity, low birthweight, and perinatal and neonatal mortality.^(1-2, 6, 10-12) It is estimated that favorable pregnancy outcomes are compromised by 30 to 45 percent when women have anemia.^(3,13-14)

Because the consequences of anemia increase as hemoglobin falls, the prevalence of severe anemia (Hb<7 g/dl) should be of concern and warrants special actions. While severe anemia makes up a relatively small proportion of overall anemia in most countries, a public health problem exists when even two percent of pregnant women have severe anemia because of the poor birth and delivery outcomes associated with very low hemoglobin.⁽¹⁵⁾

Where the cost of screening is affordable, it is possible to screen for iron deficiency several times during pregnancy and instruct women to take iron pills as needed. In these situations, other causes of anemia (i.e., vitamin B-12 and folic acid deficiencies) can be assessed and treated appropriately. Given the life-threatening consequences of severe anemia, it is also desirable to identify women with severe anemia, so they can be given more iron and treated for other causes of anemia such as parasitic infections. Women with severe anemia should receive follow-up and be referred to a higher level health facility if their hemoglobin values do not reach a safe range before labor and delivery.

A dilemma exists in developing countries because in order to identify severe anemia, blood samples need to be collected for every woman attending prenatal care sessions. In countries where screening supplies are costly and not consistently available and where taking a finger prick of blood may be invasive, other methods are needed to identify women with severe anemia.

One low-cost method for identifying cases of anemia is through clinical examinations for pallor, although this method is generally recognized as having low sensitivity for all anemia (Hb<11 g/dl). While the World Health Organization (WHO)⁽¹⁶⁻¹⁷⁾ recommends that all pregnant women be clinically screened for anemia as part of their antenatal check-up, there have been no recommendations for using pallor screening to identify women with severe anemia. The purpose of this paper is to review the literature and results from recent field trials to determine if this method is useful in identifying severe anemia and to make recommendations on using pallor screening to detect severe anemia.

METHODS

A Medline search of the literature from 1978 to 1997 was used to identify studies for review. Key words used to conduct the search included: "anemia and pallor;" "anemia and clinical signs;" "testing, sensitivity, and anemia;" and "anemia and physical examination." Because it was of interest to show how clinical signs can be used to identify anemia, studies were used where sensitivities¹ of the exams were reported or could be calculated. In addition to the literature review, iron specialists and journal article authors were contacted.

In two MotherCare-supported² anemia prevalence surveys involving over 600 pregnant women, pallor screening was conducted before hemoglobin values were taken using the HemoCue®.

RESULTS

Seventeen studies were identified in which pallor was used as a screening tool to identify anemia.^(1, 19-34) Four of these studies were conducted with Western populations,^(20, 30-31, 33) and 13 of these studies were conducted with developing country populations.^(1, 19, 21, 22-29, 32, 34) Five studies included mixed populations of men, women, pregnant women, adolescents, and children.^(24-25, 27-28) Three studies were with women,^(1, 26, 34) two studies with men,^(19, 30) and two studies were with children under 5 years of age.⁽²¹⁻²²⁾ Four studies were with adult men and women,^(20, 29, 31, 33) and one study gave no description of the study population.⁽²³⁾ Physicians and other health workers of various skill levels and experience conducted the screenings. The studies varied in the detail they provided on training, examination procedures, and environmental conditions during the exam. Most of these studies examined paleness of several different areas, such as the face, nail beds, tongue, palms, and the conjunctivae and compared them against a gold standard for hemoglobin, including the HemoCue®, copper sulfate method, cyanmethemoglobin method, the Coulter counter, and the hemoglobinometer.³

The majority of the studies reviewed define anemia according to hemoglobin levels, although two studies used hematocrit values.⁽¹⁹⁻²⁰⁾ Another study⁽³³⁾ used "likelihood ratios" instead of sensitivity and specificity. We have converted the likelihood ratios to sensitivity and

Sensitivity is the ability to correctly identify those who have the disease and is calculated by taking the number of true positives (TP) divided by the number of TP plus the number of false negatives (FN) or TP/TP+FN. *Specificity* is the ability to identify those who do not have the disease and is calculated by the number of true negatives (TN) divided by the number of TN plus false positives (FP) or TN/TN+FP. Sensitivity and specificity are determined by comparing the results of the screening test with a "gold standard" or definitive diagnostic procedure (i.e. a laboratory test) [18].

MotherCare is a John Snow, Inc. program funded by the United States Agency for International Development (USAID).

³ For a description of these methods, refer to Anemia Detection in Health Services. Guidelines for Program Managers. by Path, HealthTech, OMNI. December, 1996.

specificity in order to compare them to the other studies. In one study, ⁽²⁹⁾ researchers estimated hemoglobin levels by examination of pallor and compared these to laboratory estimates; they did not calculate sensitivity and specificity.

Most of the research shows that in conducting clinical screenings of anemia, such as pallor in a variety of body sites, sensitivity is highest for identifying cases of severe anemia (<7g/dl). Sensitivities are usually lower in detecting mild to moderate anemia (8-11g/dl) while specificities tend to be higher. A more detailed review of the literature follows and **Tables 1 and 2** provide additional detail.

Developing Country Setting

Children under 5 years of age

“Luby, et al” ⁽²¹⁾ evaluated the ability of health workers in rural Malawi to identify anemia in 1104 children under 5 years of age by using clinical signs. Health workers used their own judgment to assess the severity of pallor and graded pallor as either “definite,” “probable,” or “absent.” The sensitivity and specificity for pallor were highest (93% and 56% respectively) for severe anemia (Hb<5g/dl). The sensitivity and specificity of pallor screening were 66 and 68 percent respectively for moderate anemia. The researchers found that for each examination site, children with “definite” pallor had significantly lower hemoglobin than children with “probable” pallor; and, children with “probable” pallor had significantly lower hemoglobin than those where pallor was “absent.”

A cross-sectional study by Thaver and Baig ⁽²²⁾ tried to detect the validity of diagnosing anemia by examination of the conjunctiva, tongue, nails, and palms in children living in a squatter settlement in Karachi, Pakistan. Clinical exams, when using only one site, were best using the conjunctiva, giving a sensitivity of 74% and specificity of 64%. A combination of at least two sites increased sensitivity to 78% but decreased specificity to 62%. When the conjunctiva was combined with nails and with the tongue, sensitivities were 75.6% and 75.2% respectively, and specificities were 63.5% and 63.1% respectively.

No description of study population

Sanchez-Carrillo ⁽²³⁾ looked at the degree to which the conjunctival hue biased the diagnosis of anemia in 219 ambulatory patients in Mexico. The color of the conjunctiva was classified as either “pink” (associated with anemia) or “reddish” (not anemic). The overall sensitivity using conjunctival hue to identify anemia was 37%. The field workers correctly identified 52% of patients with pink hue as anemic and 38.9% with reddish hue as non-anemic.

Men and Women

“Jacobs, et al”⁽²⁹⁾ conducted a study of 74 white hospitalized patients in South Africa. Subjects were admitted to the hospital because they had been diagnosed as anemic or had signs of facial pallor. Results of the study showed the conjunctiva, the oral mucosa, and the tongue were the sites that gave the most accurate results in comparing what the observer noted as the hemoglobin level with the laboratory results.

Adolescents and Adults (men and women over 12 years of age)

In another study by “Sanchez-Carrillo, et al”⁽²⁴⁾ in Mexico, color shades⁴ resembling the conjunctiva at different levels of hemoglobin were tested on 200 men and women who had been referred for blood testing. Sensitivity was 63% for Hb<13g/dl and specificity was 72%. Sensitivity at 7 to 11g/dl was the lowest with 58%; but this cumulative range had the highest specificity at 86 percent.

Men, Women and Children

Ekunwe⁽³²⁾ examined conjunctival pallor in 2697 men, women and children in Lagos, Nigeria. Thirty percent of the study population was anemic (Hb<10g/dl). Sensitivity for pallor was 25% and specificity was 89%.

In a study by “Kahn, et al”^(2,5) 113 men, women, and children of a large, urban community in India had their hemoglobin concentration tested and were examined for clinical signs of anemia (conjunctiva, skin, nail beds). Sensitivity for pallor was 31.9%. The prevalence of anemia from the clinical assessment of pallor was 25.7% while the laboratory estimation of hemoglobin concentration was 80.5%.

Ghosh and Mohan⁽²⁷⁾ used an anemia recognition card⁵ to detect anemia in 926 children, adults, and pregnant women in India. Using this card, field workers were able to correctly identify 100% of patients with severe anemia (<6g/dl), 66% of those with moderate anemia (6-9g/dl), and 50% of patients with mild anemia (Hb 9-11g/dl). In addition, 70 to 80% of all subjects with hemoglobin above 11g/dl were correctly identified as non-anemic.

“Wurapa, et al”⁽²⁸⁾ assessed conjunctival pallor in 951 men, women and children in Zambia. Two physicians conducting the exams found very different sensitivities for pallor

The color shades consisted of six photographic images of eye conjunctiva with different shade intensities. They were selected on their photographic and color quality, transferred to template phototype sectors and then re-photographed. Prints of 6.5 by 8.5 cm were made of the instrument prototype. The tool was developed as a way to measure hemoglobin concentrations without the extraction of blood. Hemoglobin concentration values representing, from lighter to darker, were cutoff levels of Hb 7-8g/dl, 9-11g/dl, 12-13g/dl, 14-16g/dl, 17-19g/dl and 20g/dl or >.

An anemia recognition card was developed by the Voluntary Health Association of India to help community health workers identify anemia by pallor signs (for lips and tongue). The card has two colored pictures- one of a very pale tongue and lips and the other of a pink tongue and lips.

screening. Sensitivity for Physician A was 32.7% and only 4% for Physician B. For both examiners, sensitivity was 18.6%. Specificity for Physician A was 90.4% and 100% for Physician B. For both, specificity was 95.8%.

Women

“Meda, et al”⁽³⁴⁾ examined conjunctival pallor in 251 women of reproductive age in Bobo Dioulasso, Burkina Faso. Overall sensitivity for conjunctival pallor was 16%. Sensitivity of conjunctival pallor for women with Hb less than 10 g/dl, was 43% and for women with Hb <7 g/dl, sensitivity was 100%.

Yip ⁽¹⁾ assessed pallor in 743 Ethiopian refugee women in Somalia. Fifty-three percent of women with severe anemia (Hb <7g/dl) were identified; specificity was 90.6%.

“Gujral, et al”⁽²⁶⁾ looked at the sensitivities and specificities of clinical examinations for pallor using the anemia recognition card in 211 pregnant women from rural and tribal villages in Gujarat, India. Sixty-seven percent of women with anemia (Hb <8g/dl) were identified; specificity was 41%.

In MotherCare-supported research in Malawi, 197 women were examined for conjunctival pallor. Sensitivity for identifying women with severe anemia was 83.3% (N=5) and specificity was 80%. Sensitivity for moderate anemia (7-10.9 g/dl) was 25%. In Indonesia, 409 women were examined and sensitivity for conjunctival pallor was 100% for severe anemia (N=5) and specificity was 80%.

Men

“Glass, et al”⁽¹⁹⁾ estimated the hematocrit value of 64 male agricultural workers in Guatemala based on clinical examination of conjunctival pallor. Results showed that the examiners underestimated the laboratory hematocrit values in 89% of the subjects. In measuring the sensitivity and specificity, all five examiners achieved a sensitivity and specificity of 70% or greater.

Western Country Setting

Men and Women

“Sheth, et al”⁽³³⁾ examined conjunctival pallor in 302 patients in Toronto, Canada. Sensitivity for pallor classified as present or borderline was 54.5% and specificity was 74.9%.

In a study by “Nardone, et al”⁽²⁰⁾ physicians examined the conjunctiva, face, nail beds, palms, and palmar creases of 103 white patients in Oregon, USA. At a hematocrit cutoff of .40, sensitivity was 65% for pallor at either the conjunctiva, the face, or the palms. Sensitivity for the palms alone was 53%. At .30 hematocrit, sensitivity improved to 80% for pallor at any one of three sites (conjunctiva, face, or palms).

“Gjorup, et al”⁽³¹⁾ looked at results from examinations of the skin, nail beds and conjunctiva of 180 patients in a hospital in Denmark. Overall accuracy⁶ of the three physician examiners was 78% to 79%. Results showed that there was a correlation between the clinical assessment of anemia and lower hemoglobin levels. Two physicians had overall sensitivities of 44% and specificities of 88%. The third had a sensitivity of 27% and a specificity of 95%. While all examiners agreed on the absence of anemia in 123 patients or 68%, they only agreed on the presence of anemia in seven patients or four percent.

Men

“Strobach, et al”⁽³⁰⁾ conducted a prospective study of 50 white men in Missouri, USA. The physicians examined five physical signs of anemia (conjunctival pallor, conjunctiva vascularity, nail bed pallor, nail bed blanching with palpitation and palmar creases). They used a color tint selector⁷ placed adjacent to the lower eyelid to compare the conjunctiva. Sensitivity for those with severe anemia was 81% for both conjunctiva pallor and the absence of nail bed blanching. Sensitivities for nail bed pallor and palmar creases were 56% and 50% respectively. The authors found a statistically significant correlation between hemoglobin concentration and the color tint of the conjunctiva. A statistically significant relationship was also found between hemoglobin concentration and conjunctival vascularity, conjunctival pallor, nail bed pallor, and the absence of nail bed blanching and palmar crease pallor.

Overall accuracy is calculated by $TP + TN/n$.

The Pantone color tint selector was purchased at a paint store. Before they began the study, the researchers matched a color from the tint selector to the conjunctiva of people with hemoglobins of 12-13g/dl for a base color considered to be “normal” conjunctiva. Then they matched the conjunctiva of people with lower hemoglobin levels to other colors on the selector. (35)

DISCUSSION

While pallor has been extensively used in the antenatal care setting to identify cases of anemia, it is not useful in identifying the entire spectrum of anemia from mild to severe (i.e., Hb < 11 g/dl for pregnant women). In fact, some researchers feel that screening is not useful due to individual variability of the subject.⁽³⁶⁻³⁷⁾ The authors of this review agree that there is wide variation in results (16-78% sensitivity) in identifying those with anemia but disagree that it is only due to subject differences. Instead, the accuracy of the measurement is also due to the body part being examined and the health worker's skill. From this review, it appears to be possible, using the conjunctiva in adults, to identify at least 50% of all subjects with mild to severe anemia. In field trials conducted by the MotherCare project and its partners, health workers used conjunctival pallor and were able to identify 25 to 26% of pregnant women with a hemoglobin less than 11 g/dl.

From the studies reviewed here, there may be several ways to improve the sensitivity of using clinical signs to identify anemia. It is clear that the accuracy of pallor screening is not dependent on years of clinical experience.^(19, 29, 31) Instead, the sensitivity of pallor screening can improve when health workers are trained specifically to identify anemia using clinical signs and to use the best body sites and environmental setting while doing the exam.^(22, 27, 38-40) Two studies⁽²¹⁻²²⁾ found that all levels of health workers (e.g., in the community, at facilities) with training were successful in identifying signs of anemia, especially moderate to severe levels. Immediate feedback, where workers detect pallor and compare their results with an accurate test for hemoglobin, appears to be an important component of training.^(19, 24) In a study in Kenya, using clinical signs to detect anemia was more accurate when health workers knew their own hemoglobin values and were able to use their own palms to compare with the palms of children.⁽⁴¹⁾

The use of different sites to improve the sensitivity of pallor screening is not conclusive. Generally, a combination of sites (conjunctiva, nail beds, and palmar creases) can improve sensitivity.⁽³⁹⁾ When using only a single site, the conjunctiva in adults is best because it is not affected by race and requires less training to obtain accurate results.⁽³⁹⁾ For children, nail beds and palmar pallor seem the most useful,⁽⁴⁰⁻⁴¹⁾ possibly because the surface area of the conjunctiva is too small in children.

Environmental conditions may affect the accuracy of pallor screening. For example, examining subjects in a well-lit room or in daylight is preferred.^(27, 39) In areas where women cook indoors, smoke may cause unusually high incidence of conjunctivitis, causing hyperemia or an unusual amount of blood flow to this part of the body.⁽²⁹⁾ The use of tobacco or betel leaf can discolor the tongue, mouth, and hands, making clinical examination difficult.⁽²⁷⁾

Several studies^(24, 26-27, 30) reviewed here used comparison aids to increase the sensitivity of pallor screening. Only one study⁽³⁰⁾ showed that a comparison guide produced high sensitivities,

in this case a color tint selector. Even if comparison aids did increase sensitivity substantially, they may be expensive and difficult to maintain.

Pallor screening is usually conducted to target limited supplies of iron/folate (IFA) supplements. Using pallor screening, only 50% of women will be identified as anemic and receive iron pills, which is probably not an effective public health strategy. Instead, health workers need to be aware that pallor screening is not sensitive enough to detect the majority of pregnant women with anemia and that enough IFA pills should be procured so that all women receive the recommended number of pills during pregnancy.⁸

It is clear from the studies reviewed here and the MotherCare field studies that pallor screening is a more sensitive tool for identifying women with severe anemia, although the number of these studies is small. In five of the six studies that looked at cases of severe anemia (Hb < 7g/dl or below), it was possible to correctly identify 93 and 100% of individuals with severe anemia. In the sixth study, researchers were only able to detect 53% of the severe anemia.⁽¹⁾

Because most of the women with severe anemia will be identified through pallor screening, it makes sense to continue this type of screening but only to target special follow-up for these cases. Women with pallor who are less than 36 weeks gestational age should be given more IFA pills and, like their less anemic counterparts, counseled on the importance of taking them and asked to return within 30 days to be reexamined and questioned about pill-taking. Since women with anemia experience fatigue and often feel noticeably better after taking iron pills for a couple of weeks, the women should be asked about their energy levels—this can also be a proxy for compliance. While some women with less severe anemia will be classified as being severely anemic (e.g., false positives) using pallor screening, efforts to follow-up with women will also be beneficial since most of these women will be mildly anemic and/or iron deficient.⁽¹⁾ If women do not respond to taking IFA pills (i.e., still exhibit pallor or complain about being tired), either compliance is low, or there are other causes of anemia that should be treated. These women should be referred for a hemoglobin test. “Meda, et al.”⁽³⁴⁾ found that verification of low hemoglobin can be used to further convince women to take their iron pills.

Women who are more than 36 weeks gestational age should be referred immediately for a hemoglobin test, and the appropriate action should be taken depending on their hemoglobin status. Given the dangers of blood transfusion (e.g., HIV transmission, fluid overload, and heart failure), this route should be the last resort.⁽¹⁾

In conclusion from this review and MotherCare field trials, the recommended number of iron pills should be given routinely to all pregnant women and pallor screening should be used to identify women with severe anemia until a sensitive, low-cost test for hemoglobin is developed that makes it cost-effective to screen all women. The money saved in screening each woman should be used to train health workers to counsel women to take iron pills and to develop

Where anemia prevalence is <40% women should take 60 mg of elemental iron and 400 mcg of folic acid daily for 6 months during pregnancy; where anemia prevalence is >40% women should take 60 mg of elemental iron and 400 mcg of folic acid daily for 6 months during pregnancy and for 3 months postpartum. (15)

educational materials to improve compliance. Health workers should also be trained to correctly use pallor screening to identify women with severe anemia (Hb <7g/dl) and give them appropriate follow-up based on their gestational age. If hemoglobin tests are not routinely conducted and there is no money to put into these other activities, Ministries of Health need to make a new commitment to solving the problem of anemia by ensuring supplies of IFA, developing the best messages to ensure compliance, and training health workers to improve their counseling skills.

Table 1: Pallor Studies in Developing Countries

Study	General Description Country, N, Type Of Examiner	Gold Standard	Hemoglobin/ Hematocrit Cutoff Levels	Sensitivity/Specificity	Examination Sites
Ekunwe, "Predictive Value of Conjunctival pallor in the Diagnosis of Anemia", 1997	n=2,697 men, women, children in Lagos, Nigeria (1,449 males; 1,248 females) researcher conducted assessment	Oxyhaemoglobi n	Hb <10g/dl	Sensitivity: 25% Specificity: 89%	conjunctiva
Meda, et al. "Anaemia among women of reproductive age in Burkina Faso", 1996	n=251 women of reproductive age (includes pregnant, non-pregnant and lactating women) in Bobo-Dioulasso, Burkina Faso Principal Investigator trained fieldworkers	HemoCue®	Hb 12 g/dl 10 to <12 7 to <10 <7	Sensitivity: overall: 16% Hb 7 to <10: 43% Hb <7: 100%	conjunctiva
Luby, et al. "Using clinical signs to diagnose anaemia in African children", 1995	n=1104 children under 5 in rural Malawi examined by trained health care workers in two hospital-based outpatient clinics examined	HemoCue®	anemia= 5-8g/dl moderate <5g/dl severe	Sensitivity: Hb<5: 93%, 5-8: 66% Specificity: Hb<5: 57%, 5-8: 68%	conjunctiva, tongue, palm, nail beds
Thaver and Baig, "Anemia in Children: Part I. Can Simple Observations by Primary Care Provider Help in Diagnosis?", 1994	n=947 children (6-60 months) squatter settlement, Karachi Pakistan physicians examined children	HemoCue®	anemia= Hb<11Cm%	Sens: conj. 74.1% tongue 20.2% nails 14.9% palms 32.0% Spec: conj. 64.5% tongue 94.1% nails 96.1% palms 89.7% combinations conj. +: palms 78.6% nails 63.5% tongue 62.1% 63.1%	conjunctiva, tongue, nails, and palms
Yip, "Iron Deficiency: Contemporary Scientific Issues and International Programmatic Approaches", 1994	n=743 Ethiopian refugee women in Somalia	HemoCue®	Hb <7g/dl Hb <7g/dl	Sensitivity 53.4% Specificity 90.6%	Conjunctiva, tongue, nail beds, palms
Khan, et al. "Relationship of Intestinal Parasitism, Malaria, and Under Nutrition to Prevalence of Anemia in an Urban Community", 1990	n=113 men, women, children in urban India	not given	preg. woman: <11g/dl women: <12 men: <13 children: <11-12 <8g/dl	Sensitivity: 31.9%	Conjunctiva, skin, nail beds
Gujral, et al. "Agreement Between Hemoglobin Estimation and Anemia Recognition Card in Assessment of Anemia in Pregnant Women", 1989	n=211 pregnant women in 51 rural and tribal villages of Panchmahals district Gujarat, India Trained medical interns examined women	cyanmethemogl obin method		Sensitivity: 67% Specificity: 41%	lips, tongue using an anemia recognition card:
Sanchez-Carrillo, et al. "Bias due to Conjunctiva Hue and the Clinical Assessment of Anemia", 1989	219 subjects in clinic in Mexico 3 non-clinicians examined 657 independent observations: 179 as "pink" and 478 as "reddish"	not given	anemia=<9.9g/dl normal= 110g/dl	52% with pinkish hue and 38.9% with reddish hue were correctly classified as anemic or non-anemic.	Conjunctiva

Study	General Description Country, N, Type Of Examiner	Gold Standard	Hemoglobin/ Hematocrit Cutoff Levels	Sensitivity/Specificity	Examination Sites
Sanchez-Carrillo, et.al. "Test of a Non-Invasive Instrument for Measuring Hemoglobin Concentration", 1989	n=200 (118 females, 82 males all over 12 years) in Mexico 3 examiners- 2 medical professionals, 1 non-medical professional used a color shade to examine the conjunctiva	not given	Hb levels for lowest four instrument readings were cumulated: 7-8; 7-11; 7-13; 7-16g/dl	Hb <13g/dl Sensitivity: 63% Specificity: 72% Hb > 11g/dl 97% identified	conjunctiva using color shades
Wurapa, et.al. "Evaluation of conjunctival pallor in the diagnosis of anemia", 1986	n=627 examined for pallor and had hemoglobin estimates (269 males and 358 females, including children); (total population of 951 examined for pallor; 406 males and 545 females, including children) in Kampumbi, Northern Province of Zambia 2 doctors examined different groups of individuals	Coulter counter	10g/dl or less	for n=627 Sensitivity: Observer A: 32.7 Observer B: 4.0 Both: 18.6 Specificity: Observer A: 90.4 Observer B: 100 Both 95.8	conjunctiva
Glass, et.al. "The Value of Simple Conjunctival Examination in Field Screening for Anemia", 1980	n=64 male agricultural workers on a southern Guatemala coffee plantation 3 physicians, 2 medical students examined men	Cyanmethemoglobin method	Ht <36% or Hb <11.9g/dl	sensitivity and specificity >70%	conjunctiva
Jacobs, et.al. "Observer Bias and Error in the Integumentary Clinical Diagnosis of Chronic Anemia", 1979	n=74 white men and women in hospital in South Africa (44 women, 30 men with mean age 65.6 years)	Cyanmethemoglobin method	men: <14.3g/dl women: <12.3g/dl	not given	Conjunctiva, oral mucosa
Ghosh, Mohan, "Screening for Anemia", 1978	n=926; 528 children; 207 adults; 151 pregnant women in India; 4 field workers with education and training in basic health care examined	Cyanmethemoglobin method	<6g/dl; 6-9g/dl; 9-11g/dl; and >11g/dl	Sensitivity: Hb <6g/dl: 100%; Hb:6-9g/dl: 66%; Hb 9-11g/dl: 50% Specificity: children with >11g/dl: 80%	tongue, lower lip and nails in comparison to an anemia recognition card

Table 2: Pallor Studies in Western Countries

Study	General Description Country, N, Type Of Examiner	Gold Standard	Hemoglobin/ Hematocrit Cutoff Levels	Sensitivity/Specificity	Examination Sites
Sheih, Tarang, et al. "The Relation of Conjunctival Pallor to the Presence of Anemia", 1997	n=302 (171 males, 131 females over 18 years) in Toronto, Canada racially diverse, hospital setting	not given	<9g/dl	Sensitivity: 54.5% Specificity: 74.9% (converted from Likelihood ratios)	Conjunctiva
Nardone, et al. "Usefulness of Physical Examination in Detecting the Presence or Absence of Anemia", 1990	n=103; 98 men and 5 women V.A. hospital in Oregon, USA all whites mean age: 60 years	Not given	Hematocrit cutoffs used for this study .30, .35, .40 anemia hematocrit cutoffs typically: <.41 for men <.36 for women	Sensitivity: .40 Hct/Hb 13 -palms-53% pallor at any site:-65% Specificity: .40 Hct/Hb 13 -palmar creases- 100% pallor at any site:-95% Sensitivity: .35 Hct/Hb 12 -palms- 64% pallor at any site:-77% Specificity: .35 Hct/Hb 12 -palmar creases- 99% pallor at all 3: 94% Sensitivity: .30 Hct/Hb 10 -palms-67% pallor at any site 80% Specificity: .30 Hct/Hb 10 -palmar creases- 98% -pallor at all 3: 87%	conjunctiva, palms, face
Sirobach, et al. "The Value of the Physical Examination in the Diagnosis of Anemia", 1988	n=50 white males in a Veterans' Administration hospital in Missouri, USA physicians examined men	not given	anemia= <12g/dl severe: <10g/dl moderate: 11-12g/dl	anemia <10 g/dl conj. pallor/ absence nail bed blanching 81 % nail bed pallor: 56% palmar crease: 50% anemia 10-10.9 g/dl conj. pallor/ absence of nail bed blanching: 50% nail bed pallor: 16% palmar crease: 33%	conjunctiva, nailbeds, palmar creases
Gjorup, et al. "A Critical Evaluation of the Clinical Diagnosis of Anemia", 1986	n=180 (108 women and 72 men; hospital based) in Denmark median age was 69 3 physicians examined patients	Hemalog 8	Reference intervals (mmol/liter): -men: 8.0-11.0 -women: 7.0-10.	Sensitivity range: .27-.44 Specificity range: .88-.95	skin, nail beds, conjunctiva

Type of Study	# of Subjects	Gold Standard	Sensitivity/Specificity %	Reference #	Hb or Ht cutoff	Examination site
Adults						
Men and women adolescents	74	cyanmethemoglobin		29	men <14.3 women <12.3	conjunctiva oral mucosa
	302	not given	54.5 / 74.9	33	<9	conjunctiva
	103	not given		20	.30, .35, .40	conjunctiva, palms, face
	180	Hemalog 8	27-44 / 88-95	31	men 8-11 women 7-10	conjunctiva nailbeds, skin
Men, women and adolescents	200	not given	63 / 72	24	<13	conjunctiva
Women						
	251	HemoCue®	sensitivity: overall 16 7-<10: 43 <7: 100	34	12, 10-<12, 7-<10, <7	conjunctiva
	743	HemoCue®	53.4 / 90.6	1	17, <7	conjunctiva, tongue, nailbeds, palms
	211	cyanmethemoglobin	67 / 41	26	<8	lips, tongue
Men	64	cyanmethemoglobin		19	<11.9	conjunctiva
	50	not given		30		conjunctiva palmar creases nailbeds
Children						
	1104	HemoCue®	sensitivity <5: 93%; 5-8: 66% specificity: <5: 57%; 5-8-68%	21	5-8 moderate <5 severe	conjunctiva, tongue, palms, nailbeds
	947	HemoCue®	Sens: Spec: conj. 74.1% 64.5% combination conj. and palms 8.6% 62.1% nails 5.6% 63.5% tongue 75.2% 63.1%	22	<11	conjunctiva, tongue, nails, palms

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