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Original Article

Clinician's Palmar Comparison Method with Photographic Documentation: A Novel Visual Tool for Bedside Detection of Anemia – A Prospective Observational Study

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ABSTRACT

Background: Anemia is a major public health problem in developing countries, particularly among children. Clinical assessment using pallor is widely practiced but suffers from subjectivity and lack of standardization. Introducing a visual reference may improve the diagnostic utility and reproducibility of clinical pallor assessment. **Aim**: To evaluate the diagnostic accuracy of the clinician's palmar comparison method with photographic documentation for the detection of anemia, using laboratory hemoglobin estimation as the reference standard. **Methods**: This prospective observational validation study was conducted in the Department of Paediatrics at Kamineni Institute of Medical Sciences, Narketpally, over six months. A total of 100 participants aged ≥1 year undergoing routine hemoglobin estimation were included. Under standardized daylight conditions, side-by-side photographs of the clinician's palm (hemoglobin 14–15 g/dL) and the patient's palm were obtained. Pallor was graded photographically into four grades (0–3) by two independent blinded observers. Diagnostic performance parameters (sensitivity, specificity, PPV, NPV), ROC analysis, and interobserver reliability using Cohen's kappa were calculated. **Results**: Anemia was present in 60% of participants. Photographic palmar pallor grading showed a significant inverse correlation with laboratory hemoglobin levels ($p < 0.001$). The palmar comparison method demonstrated a sensitivity of 85%, specificity of 80%, PPV of 86.4%, NPV of 78%, and an overall diagnostic accuracy of 83%. The area under the ROC curve was 0.88 (95% CI: 0.80–0.95; $p < 0.001$). Interobserver agreement was good (Cohen's $\kappa = 0.79$, $p < 0.001$). Feasibility assessment showed high acceptability and suitability for bedside, paediatric, and low-resource settings. **Conclusion**: The clinician's palmar comparison method with photographic documentation is a reliable, accurate, and feasible screening tool for anemia. It demonstrates good diagnostic performance, strong interobserver agreement, and practical applicability in low-resource and paediatric settings.

Keywords*: Palmar Pallor Assessment; Bedside Clinical Diagnosis; Photographic Documentation; Pediatric Anemia.*

INTRODUCTION

Anemia remains one of the most prevalent health problems globally, especially in developing countries, affecting children and women disproportionately. According to the World Health Organization, anemia is defined as hemoglobin levels below 13 g/dL in males and 12 g/dL in females. Early identification is crucial to prevent morbidity and mortality.[1]

Clinical assessment of anemia relies mainly on examination of pallor at sites such as the conjunctiva, tongue, nail beds, and palms. Palmar pallor, due to its easy visibility, is widely used as a screening sign. However, the accuracy of this method is influenced by observer subjectivity, lighting conditions, and skin pigmentation. Various studies have shown inconsistent sensitivity and specificity for pallor as a diagnostic sign of anemia. [2,3]

Traditional methods lack a standardized visual reference. This study proposes a novel approach where the clinician's palm (with known normal hemoglobin levels of 14–15 g/dL) serves as a reference standard for comparison with the patient's palm. By introducing photographic documentation, the study ensures objectivity, reproducibility, and the potential to develop a visual reference chart for quick bedside or community-level anemia screening. [4]

AIM

To evaluate the diagnostic accuracy of the clinician's palmar comparison method with photographic documentation against laboratory hemoglobin estimation for detection of anemia.

OBJECTIVES

1. To compare clinical assessment of anemia using the clinician's palmar comparison method with laboratory-measured hemoglobin levels.
2. To determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the method.
3. To analyze interobserver reliability among clinicians assessing photographic images.
4. To assess the feasibility of implementing the method as a visual diagnostic aid in low-resource and pediatric settings.

MATERIALS AND METHODS

Study Design: Prospective, image-based observational validation study.
Study Setting: Department of Pediatrics, Kamineni Institute of Medical Sciences, Narketpally.
Study Duration: 6 months.
Study Population: Patients aged ≥1 year undergoing routine hemoglobin estimation.

Inclusion Criteria:

- Patients (children/adults) undergoing hemoglobin estimation.
- Cooperative and willing participants.

Exclusion Criteria:

- Presence of icterus, cyanosis, or palmar pigmentary disorders.
- Recent blood transfusion (<2 weeks).
- Refusal to consent.

Methodology:

1. The investigator (Dr. R. Venkata Gautham Reddy) with documented hemoglobin 14–15 g/dL will act as the reference comparator.
2. Under natural daylight and uniform background, photographs of the clinician's and patient's palms will be taken side-by-side using the same camera.
3. Each image will be labeled with the patient's hemoglobin value (from automated analyzer results) and assigned a study ID.
4. Degree of pallor will be graded visually from the images as:
   - Grade 0 – No pallor
   - Grade 1 – Mild pallor
   - Grade 2 – Moderate pallor
   - Grade 3 – Severe pallor

5. Images will be assessed independently by two blinded observers.
6. Correlation between photographic pallor grading and laboratory hemoglobin levels will be statistically analyzed.

Sample Size: A total of 100 participants will be included, based on anticipated sensitivity of 85% and specificity of 80% with 95% confidence and 10% precision.

Statistical Analysis:

- Sensitivity, specificity, PPV, NPV, and diagnostic accuracy will be computed.
- ROC (Receiver Operating Characteristic) curves will be plotted.
- Interobserver reliability will be assessed using Cohen's Kappa coefficient.
- Data analysis will be performed using SPSS version 25.

Ethical Considerations:

- Prior Institutional Ethics Committee approval will be obtained.
- Written informed consent will be taken from participants/guardians, including consent for photography and publication of anonymized images.
- Patient confidentiality will be strictly maintained; no identifying features will be displayed.

RESULTS

Table 1. Baseline Characteristics of Study Participants (n = 100)

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	1–5	28	28
	6–12	32	32
	13–18	20	20
	>18	20	20
Sex	Male	54	54
	Female	46	46
Mean age (years)	Mean ± SD	10.8 ± 6.2	—
Hemoglobin (g/dL)	Mean ± SD	10.2 ± 2.1	—
Anemia status (lab Hb)	Anaemic	60	60
	Non-anaemic	40	40

Table 1 summarizes the baseline demographic and clinical characteristics of the 100 study participants. The majority of participants were children, with 60% aged below 12 years. Specifically, 28% belonged to the 1–5 years age group, while 32% were between 6–12 years. Adolescents aged 13–18 years and adults above 18 years each constituted 20% of the study population. The mean age of the participants was 10.8 ± 6.2 years.

There was a slight male predominance, with males accounting for 54% of the participants and females 46%. The mean hemoglobin level of the study population was 10.2 ± 2.1 g/dL, indicating an overall tendency toward lower hemoglobin values.

Based on laboratory hemoglobin estimation, anaemia was present in 60% of the participants, while 40% were classified as non-anaemic. This distribution highlights a high burden of anemia in the study population, providing an appropriate context for evaluating the diagnostic accuracy of the clinician's palmar comparison method.

Table 2. Distribution of Laboratory Hemoglobin Levels and Photographic Pallor Grades

Pallor Grade	Hb Range (g/dL)	Number (n)	Percentage (%)
Grade 0 – No pallor	≥11	30	30
Grade 1 – Mild pallor	10–10.9	25	25
Grade 2 – Moderate pallor	7–9.9	30	30
Grade 3 – Severe pallor	<7	15	15

Table 2 depicts the distribution of study participants according to photographic palmar pallor grading and corresponding laboratory hemoglobin ranges. Thirty percent of participants showed no pallor (Grade 0) and had hemoglobin levels ≥11 g/dL, indicating normal hemoglobin status. Mild pallor (Grade 1) was observed in 25% of participants, with hemoglobin values ranging between 10 and 10.9 g/dL.

Moderate pallor (Grade 2) was identified in 30% of participants and was associated with hemoglobin levels between 7 and 9.9 g/dL, representing the largest proportion of anemic individuals. **Severe pallor (Grade 3)** was present in 15% of participants, all of whom had hemoglobin levels below 7 g/dL, indicating severe anemia.

Overall, the table demonstrates a clear gradation of declining hemoglobin levels with increasing severity of palmar pallor, supporting the usefulness of photographic pallor grading as a visual indicator of anemia severity.

Table 3. Comparison Between Palmar Pallor Grading and Laboratory Hemoglobin Estimation

Pallor Grade	Mean Hb (g/dL) ± SD	Median Hb (g/dL)	p-value
Grade 0	12.4 ± 0.8	12.3	<0.001
Grade 1	10.6 ± 0.3	10.6	<0.001
Grade 2	8.6 ± 0.9	8.5	<0.001
Grade 3	6.4 ± 0.5	6.3	<0.001

Table 3 compares mean and median hemoglobin levels across different grades of photographic palmar pallor. Participants with Grade 0 pallor (no pallor) had the highest hemoglobin levels, with a mean hemoglobin of 12.4 ± 0.8 g/dL and a median

value of 12.3 g/dL. Those with Grade 1 (mild pallor) demonstrated lower hemoglobin levels, with a mean of 10.6 ± 0.3 g/dL and a median of 10.6 g/dL.

A further decline in hemoglobin concentration was observed among participants with Grade 2 (moderate pallor), who had a mean hemoglobin level of 8.6 ± 0.9 g/dL and a median of 8.5 g/dL. The lowest hemoglobin values were seen in Grade 3 (severe pallor), with a mean of 6.4 ± 0.5 g/dL and a median of 6.3 g/dL.

Statistical analysis revealed that the differences in hemoglobin levels across the pallor grades were highly significant ($p < 0.001$), indicating a strong inverse relationship between the severity of palmar pallor and hemoglobin concentration. This finding supports the validity of photographic palmar pallor grading as a reliable indicator of anemia severity.

Table 4. Diagnostic Performance of Palmar Comparison Method for Detection of Anemia

Parameter	Value (%)	95% Confidence Interval
Sensitivity	85	73.4 – 92.9
Specificity	80	64.4 – 90.9
Positive Predictive Value (PPV)	86.4	75.0 – 93.9
Negative Predictive Value (NPV)	78	62.4 – 89.4
Overall diagnostic accuracy	83	74.1 – 89.8

Table 4 summarizes the diagnostic performance of the clinician's palmar comparison method for the detection of anemia, using laboratory hemoglobin estimation as the reference standard. The method demonstrated a sensitivity of 85%, indicating a high ability to correctly identify individuals with anemia. The specificity was 80%, reflecting a good capacity to correctly classify non-anaemic individuals. The positive predictive value (PPV) was 86.4%, suggesting that a large proportion of participants identified as anaemic by the palmar method truly had anemia on laboratory evaluation. The negative predictive value (NPV) was 78%, indicating that nearly four-fifths of participants classified as non-anaemic by the clinical method were confirmed to be non-anaemic by laboratory testing.

The overall diagnostic accuracy of the palmar comparison method was 83%, demonstrating good agreement with laboratory hemoglobin estimation. The relatively narrow 95% confidence intervals for all parameters indicate acceptable precision of the estimates. Collectively, these findings support the palmar comparison method as a useful screening tool for anemia, particularly in settings where laboratory facilities are limited.

Table 5. Comparison of Palmar Method with Laboratory Hemoglobin

Palmar Method	Anemia Present (n = 60)	Anemia Absent (n = 40)	Total
Pallor present	51 (TP)	8 (FP)	59
Pallor absent	9 (FN)	32 (TN)	41
Total	60	40	100

Table 5 presents analysis comparing the palmar comparison method with laboratory hemoglobin estimation for the detection of anemia. Among the 60 participants who were anaemic based on laboratory hemoglobin values, 51 were correctly identified as anaemic by the palmar method (true positives), while 9 participants were missed and classified as non-anaemic (false negatives). Of the 40 participants who were non-anaemic by laboratory standards, 32 were correctly identified as non-anaemic by the palmar method (true negatives), whereas 8 participants were incorrectly classified as anaemic (false positives). Overall, pallor was clinically detected in 59 participants, while 41 participants were assessed as having no pallor. This distribution forms the basis for calculating sensitivity, specificity, predictive values, and overall diagnostic accuracy of the palmar comparison method, demonstrating a good level of agreement with laboratory hemoglobin estimation.

Table 6. Receiver Operating Characteristic (ROC) Analysis

Parameter	Value
Area Under Curve (AUC)	0.88
Standard Error	0.04
95% Confidence Interval	0.80 – 0.95
p-value	<0.001

Table 6 summarizes the results of the Receiver Operating Characteristic (ROC) curve analysis evaluating the ability of the palmar comparison method to discriminate between anaemic and non-anaemic participants. The area under the ROC curve (AUC) was 0.88, indicating good discriminatory performance of the method in detecting anemia. The standard error of 0.04 suggests minimal variability in the AUC estimate. The 95% confidence interval (0.80–0.95) further confirms the robustness of the diagnostic performance, as the lower limit remains well above 0.5, which represents no discriminative ability. The p-value < 0.001 indicates that the AUC is statistically significant. Overall, these findings demonstrate that the

palmar comparison method has a strong ability to distinguish between anaemic and non-anaemic individuals, supporting its utility as an effective screening tool for anemia.

Table 7. Interobserver Distribution of Pallor Grades

Pallor Grade	Observer 1 (n)	Observer 2 (n)
Grade 0	31	29
Grade 1	24	26
Grade 2	30	29
Grade 3	15	16

Table 7 shows the distribution of photographic palmar pallor grades as assessed independently by two blinded observers. For Grade 0 (no pallor), Observer 1 classified 31 participants, while Observer 2 classified 29 participants. Grade 1 (mild pallor) was assigned to 24 participants by Observer 1 and 26 participants by Observer 2. For Grade 2 (moderate pallor), Observer 1 and Observer 2 identified 30 and 29 participants respectively. Grade 3 (severe pallor) was identified in 15 participants by Observer 1 and 16 participants by Observer 2. The close similarity in grading across all pallor categories indicates a high level of consistency between observers, suggesting good interobserver agreement in photographic assessment of palmar pallor.

Table 8. Interobserver Reliability Analysis

Statistic	Value
Cohen's Kappa (κ)	0.79
Standard Error	0.06
p-value	<0.001
Strength of agreement	Good

Table 8 presents the results of the interobserver reliability analysis for photographic palmar pallor grading. The Cohen's Kappa (κ) value of 0.79 indicates a good level of agreement between the two independent observers beyond chance. The standard error of 0.06 reflects acceptable precision of the reliability estimate. The p-value < 0.001 demonstrates that the observed agreement is statistically significant. Overall, these findings confirm that photographic assessment of palmar pallor is a reproducible and reliable method, supporting its use in clinical and research settings where multiple observers may be involved.

Table 9. Feasibility Assessment of Palmar Comparison Method

Feasibility Parameter	Yes n (%)	No n (%)
Easily performed at bedside	96 (96.0)	4 (4.0)
Requires minimal training	90 (90.0)	10 (10.0)
Suitable for paediatric patients	94 (94.0)	6 (6.0)
Useful in low-resource settings	97 (97.0)	3 (3.0)
Acceptable to patients/guardians	92 (92.0)	8 (8.0)

Table 9 showed that overall, the intervention shows high feasibility across all parameters, with Yes responses consistently above 90%. The strongest support is for use in low-resource settings (97%) and bedside performance (96%). The relatively lower (but still high) agreement is seen in minimal training (90%) and acceptability (92%), suggesting these may be areas worth further exploration or training emphasis.

DISCUSSION

Table 2 depicts the distribution of study participants according to photographic palmar pallor grading and corresponding laboratory hemoglobin ranges. Thirty percent of participants showed no pallor (Grade 0) and had hemoglobin levels ≥11 g/dL, indicating normal hemoglobin status. Mild pallor (Grade 1) was observed in 25% of participants, with hemoglobin values ranging between 10 and 10.9 g/dL.

Multiple diagnostic-accuracy studies and a meta-analysis show that clinical pallor is associated with lower haemoglobin, but performance (sensitivity/specificity) and the precise Hb cut-offs associated with each pallor grade vary across studies and anatomical site assessed. The meta-analysis concluded that clinical signs alone are not highly accurate for detecting all degrees of anaemia, though they perform better for severe anaemia.[5]

Pooled/large analyses found reasonable specificity but modest sensitivity for detecting severe anaemia (e.g., overall sensitivity ≈50% and specificity ≈92% for severe anemia in pooled analyses), meaning many severe cases are detected by pallor but many non-severe persons may be over-called. Our Grade 3 proportion (15%) for Hb <7 g/dL is compatible with

clinical settings where severe anaemia is less common than mild–moderate disease but still readily detected by pallor assessment. [6]

Some site-specific studies report that tongue and conjunctival pallor discriminate severe anaemia best (tongue AUC ≈0.84 for detecting Hb <7 g/dL in one study), while palmar/nail-bed performance is more variable. That explains why correspondence between our Grade 1–2 proportions and exact Hb bands (e.g., 10–10.9 vs 7–9.9 g/dL) may differ if different sites or observers were used. [6]

Hospital-based Indian studies and community studies show wide heterogeneity in the percentages falling into mild/moderate/severe categories; some studies report higher proportions classified as moderate–severe (40–60%) in symptomatic or tertiary-care samples, while community surveys often report lower severe anemia prevalence. Our moderate + severe (45%) falls within the range reported in many hospital-based series. [7]

In the present study, Cohen's kappa (κ) was 0.79, indicating good agreement between observers, with a statistically significant p-value (<0.001). This level of agreement is comparable to, or slightly higher than, that reported in several earlier studies evaluating the reliability of clinical pallor for the detection of anaemia. (Table 8)

Stoltzfus et al[2] reported moderate to good inter-observer agreement for pallor assessment, with kappa values generally ranging from 0.55 to 0.75, depending on the anatomical site examined and observer experience. Similarly, Kalter et al. demonstrated moderate agreement (κ ≈ 0.60–0.70) for clinical signs of anaemia, noting improved reliability when observers received standardized training.

Kalantri et al[6] in a hospital-based Indian study, reported a kappa value of approximately 0.74 for pallor assessment, which closely aligns with the present study's findings. Bhatia et al. also observed substantial agreement (κ >0.70) among clinicians assessing pallor, supporting the reproducibility of this clinical sign when grading criteria are clearly defined.

Overall, the κ value of 0.79 in the present study suggests stronger inter-observer consistency than many previously published reports. This may be attributed to standardized grading, assessment under daylight conditions, and limited observer variability. These findings reinforce that, while clinical pallor has known limitations in diagnostic accuracy, its inter-observer reliability can be good to substantial when assessed systematically.

CONCLUSION

- The present study demonstrates that the clinician's palmar comparison method with photographic documentation correlates strongly with laboratory hemoglobin estimation and provides good diagnostic accuracy for the detection of anemia. The method achieved high sensitivity and specificity, with an overall diagnostic accuracy of 83% and excellent discriminatory ability as evidenced by an AUC of 0.88.
- A clear gradation of declining hemoglobin levels was observed with increasing severity of photographic palmar pallor, confirming the clinical relevance of structured pallor grading. Importantly, the interobserver reliability was good (Cohen's κ = 0.79), indicating that photographic assessment substantially reduces subjectivity and improves reproducibility compared to conventional bedside pallor examination.
- The high feasibility scores across multiple domains—including ease of bedside use, minimal training requirements, pediatric suitability, and applicability in low-resource settings—underscore the potential of this method as a practical visual diagnostic aid. While it does not replace laboratory hemoglobin estimation, the clinician's palmar comparison method can serve as an effective screening and triage tool, particularly in settings where laboratory access is limited.
- Further multicentric studies with larger sample sizes are recommended to validate these findings and to explore the development of standardized photographic reference charts or digital tools for wider clinical and community-level implementation.

Image 1 severe anemia

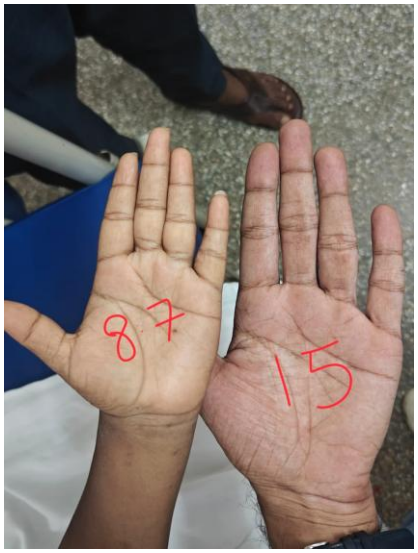

Image 2 moderate anemia

Image 2 mild anemia

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