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Clinical Examination and Haemoglobin Estimation in Diagnosis of Anemia

[1]Dr. Amber Sharma, [2]Dr. Kritika Arora, [3]Dr. Anuj Gupta, [4]Dr. Ravinder k Gupta

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Corresponding Author: Dr. Amber Sharma

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Abstract

Background: Anemia remains a significant health challenge among children aged 1–5 years, especially in resource-limited settings. Clinical pallor is a simple, non-invasive screening tool often used to identify anemia in the absence of laboratory diagnostics. This study evaluates the correlation between clinical pallor and hemoglobin (Hb) levels to determine its diagnostic utility in detecting anemia in young children.

Methods: A cross-sectional study was conducted among 378 children aged 1–5 years. Clinical pallor was assessed at three sites—conjunctiva, tongue, and palms—and categorized as absent, mild, or moderate to severe. Hb levels were measured using standard laboratory methods, and the correlation between pallor severity and Hb levels was analyzed. Sensitivity, specificity, and predictive values were calculated for varying pallor severities.

Results: A significant negative correlation ($r=-0.74$, $p<0.001$was observed between clinical pallor severity and Hb levels. Mean Hb levels were 11.7 g/dL for absent pallor, 10.3 g/dL for mild pallor, and 8.5 g/dL for moderate to severe pallor. Mild pallor exhibited high sensitivity (85.7%) but low specificity (62.3%), whereas moderate to severe pallor demonstrated lower sensitivity (61.4%) and high specificity (89.2%), making it a reliable predictor for severe anemia.

Conclusion: Clinical pallor correlates well with Hb levels and is a practical tool for anemia screening, particularly for moderate to severe cases. However, its limitations in detecting mild anemia and the influence of observer variability necessitate confirmatory testing for accurate diagnosis. Integrating pallor assessments with portable Hb-testing devices could enhance its diagnostic utility, especially in low-resource settings.

Keywords: Anemia, Conjunctiva, Hb Levels, Mild Pallor, Sensitivity

Introduction

Due to its substantial effects on growth, cognitive development, and general health, anemia is still a

major public health concern, especially in children under five (Chakrabarti et al., 2009). According to the World Health Organization (WHO), anemia in children is defined as a hemoglobin (Hb) level below 11 g/dL, with iron deficiency being the most common cause. Early detection of anemia is crucial, particularly in settings with limited resources where laboratory testing may not always be practical (WHO, 2021). A noticeable decrease in the pink hue of the skin, conjunctivae, or palms is known as clinical pallor, and it is commonly used as a stand-in for anemia in children. This straightforward, non-invasive test provides a possible screening method for medical personnel working in low-resource settings (Nardone et al., 2020). Research has indicated a correlation between Hb levels and clinical pallor; however, the degree of anemia and the observer's competence determine the association's sensitivity and specificity (Kalantri et al., 2010).

Given that children ages 1 to 5 are particularly susceptible to the negative consequences of anemia, it is crucial to comprehend the connection between clinical pallor and hemoglobin levels when diagnosing anemia in this age range (Gupte S, 2001). Assessing clinical pallor's diagnostic efficacy in this age range can help guide early intervention plans, which could lead to better results in areas with less access to laboratory testing.

Materials and methods

The present study was a cross-sectional observational study conducted to evaluate the correlation between clinical pallor and hemoglobin (Hb) levels in identifying anemia among children. The study spanned from 1st April to 30th September.

A total of 378 Children aged 1–5 years attending the outdoor wing of the department of Paediatrics, Acharya Shri Chander College of Medical Sciences (ASCOMS) were included in the study after taking an informed consent. Participants were enrolled consecutively to avoid selection bias.

The study has Ethical clearance by the Institution ethical committee (IEC) wide no. **ASCOMS/IEC/2024/Meeting-I/FM/15**

Inclusion criteria:

- Children aged 1–5 years
- Parents or guardians who provided informed consent

Exclusion criteria:

- Children with known hematological disorders (e.g., sickle cell disease, thalassemia).
- History of recent blood transfusion (within three months).
- Children with severe dehydration or acute illness affecting pallor assessment.

Data collection:

Clinical Pallor Assessment: Trained healthcare workers assessed clinical pallor using standardized protocols. Pallor was examined at three sites.

Conjuctiva: Presence of pallor in the lower eyelid

Palms: Reduced pink coloration of the palmar creases

Nail Beds: Pale nail beds compared to surrounding skin

Clinical pallor was graded as follows:

Absent (normal pink coloration)

Mild (slight paleness)

Moderate to severe (definite pale appearance)

Hemoglobin measurement:

Venous blood samples were collected under sterile conditions, and Hb levels were measured using an

automated haematology analyser. Anaemia was classified as per WHO criteria:

Mild: Hb 10–10.9 g/dL

Moderate: Hb 7–9.9 g/dL

Severe: Hb <7 g/dL

Statistical analysis:

Data were analysed using SPSS software version 25. Descriptive statistics (mean, median, and standard deviation) were used to summarize demographic data and Hb levels. The correlation between clinical pallor and Hb levels was assessed using Pearson's or Spearman's correlation coefficient, depending on data distribution. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of clinical pallor in detecting anaemia were calculated. A p-value < 0.05 was considered statistically significant

Results:

Demographic and baseline characteristics:

A total of 378 children aged 1–5 years participated in the study. The mean age of the participants was 3.2 ± 1.4 years, with 52.6% being male and 47.4% female. The prevalence of anemia (Hb <11 g/dL) among the participants was 68.5% (259 children). Of these, 45.2% had mild anemia, 39.8% had moderate anemia, and 15% had severe anemia.

Distribution of clinical pallor

Clinical pallor was observed in 276 children (73%). The distribution of pallor grades was as follows:

Absent pallor: 27% (102 children), Mild pallor: 46% (174 children), Moderate to severe pallor: 27% (102 children)

Hemoglobin levels and clinical pallor:

The mean Hb levels across different pallor grades demonstrated a significant decline with increasing severity of pallor:

Absent pallor: Mean Hb level was 11.7 ± 1.2 g/dL

Mild pallor: Mean Hb level was 10.3 ± 1.0 g/dL

Moderate to severe pallor: Mean Hb level was 8.5 ± 1.4 g/dL

Correlation between clinical pallor and haemoglobin levels

A statistically significant negative correlation was observed between the severity of clinical pallor and hemoglobin levels (Spearman’s correlation coefficient, r=-0.74, p<0.001.

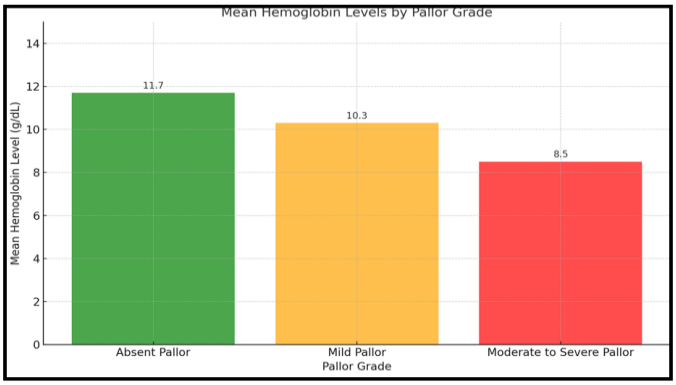
Diagnostic accuracy of clinical pallor

The diagnostic accuracy of clinical pallor for detecting anemia was evaluated, and the following results were obtained

Pallor grade	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Mild pallor	85.7	62.3	79.3	72.2
Moderate to severe pallor	61.4	89.2	85.2	69.3

Prevalence of severe Anemia and clinical pallor:

Among the 57 children with severe anemia (Hb <7 g/dL), 96.5% exhibited moderate to severe pallor, underscoring its utility in identifying severe cases



Graph 1:

Discussion

The identification of anemia in children often relies on clinical signs such as pallor, which can indicate low hemoglobin (Hb) levels (Jadav et al., 2004). However, the correlation between clinical pallor and Hb levels varies, especially in settings with limited resources. While laboratory tests for Hb concentration are the gold standard, they may not always be accessible. Several studies have explored the reliability of pallor as an alternative method for anemia screening in children (Ahmad et al., 2010; Mendez et al., 2011; Shrestha et al., 2015).

The results from the present study complement and add to the body of literature assessing the connection between children's haemoglobin (Hb) levels and clinical pallor. A comparison of our findings with those of important studies in the field shows a significant negative correlation ($r=-0.74$, $p<0.001$) between clinical pallor and haemoglobin (Hb) levels in 378 children aged 1–5 years.

With children showing no pallor having an average Hb of 11.7 g/dL, mild pallor having an average of 10.3 g/dL, and moderate to severe pallor having an average of 8.5 g/dL, mean Hb levels decreased as the severity of pallor increased. These results validate that clinical pallor is a useful indicator of anemia, particularly for moderate to severe cases. Similar trends have been reported in studies by Desalegn et al., 2019 and Nardone et al., 2020, which emphasized pallor's predictive value for significant anemia in children. Nonetheless, the need for confirmatory tests to prevent misinterpretation is highlighted by the heterogeneity of pallor in moderate cases.

It was discovered that the intensity of pallor affected its diagnostic accuracy. With a sensitivity of 85.7%, mild pallor showed that it could identify a significant percentage of children who were anaemic. Its low specificity of 62.3%, however, increased the risk of false positives. On the other hand, moderate to severe pallor was a more accurate indicator of severe anaemia, with a sensitivity of 61.4% and a high specificity of 89.2%. These results align with Kalantri et al., 2010, who reported that moderate and severe pallor are strong predictors of low Hb levels, whereas mild pallor may overestimate anaemia prevalence. Particularly in low-resource environments, the high specificity of moderate to severe pallor indicates that it can successfully target children who most urgently require care.

The subjective nature of pallor assessment presents difficulties despite its usefulness. The accuracy of a diagnosis can be impacted by variables such skin pigmentation, observer experience, and ambient lighting. For example, Luby et al., 1995, observed that trained healthcare workers were more accurate in assessing pallor, reducing variability. On the other hand, darker skin tones may make pallor less noticeable, which would lessen sensitivity, according to Desalegn et al. (2019). Even though this study used uniform training, observer variability may have affected the outcomes. Pallor assessments can bemade

more reliable by putting in place uniform grading schemes and regularly training medical staff.

The findings highlight the value of clinical pallor as a screening tool in environments with limited resources. The gold standard for detecting anemia is still laboratory testing for hemoglobin levels, but access to these tests is sometimes restricted in underprivileged communities (Stoltzfus et al., 1998). Children at risk of severe anemia can be identified early thanks to the practical triage approach of moderate to severe pallor, which has a high specificity (Chalco et al., 2005). However, as suggested by Nardone et al. (2020), combining pallor assessments with portable, reasonably priced Hb-testing equipment should improve diagnostic accuracy and lower false positives. The shortcomings of this study should be addressed in future research. More thorough information about the accuracy of pallor as a diagnostic tool might be obtained, for example, by including kids with different skin tones and assessing environmental factors like lighting. Furthermore, longitudinal research that looks at the relationship between changes in Hb levels and pallor over time may improve its application in anemia monitoring. Lastly, as proposed by Desalegn et al. (2019), assessing comorbidities that may impact pallor, such as infections or malnourishment, could improve the specificity of this method. Clinical pallor would continue to be a reliable, contextually flexible tool for anemia screening thanks to these efforts (Morris et al., 2000).

Conclusion

According to this study, clinical pallor is a useful, non-invasive screening method for identifying anemia in kids ages 1 to 5, particularly in environments with low resources. Pallor severity and hemoglobin (Hb) levels have a substantial association ($r=-0.74, p<0.001$), which validates its usefulness in detecting moderate to severe anemia. The need for confirmatory tests to reduce false positives is highlighted by mild pallor's low specificity (62.3%), despite its high sensitivity (85.7%). On the other hand, moderate to severe pallor demonstrated a high specificity (89.2%) and a lesser sensitivity (61.4%), making it a trustworthy signal for determining the order of treatment for children with severe anemia. These results are consistent with earlier studies and demonstrate the usefulness of pallor as an affordable diagnostic method in places with restricted access to lab space. The study also highlights pallor's drawbacks as a diagnostic technique, such as observer subjectivity and its lower reliability for moderate anemia. Diagnostic accuracy may be increased by addressing these issues by standardizing training for medical professionals and combining pallor assessment with portable hemoglobin testing equipment. To improve the accuracy of pallor as a screening tool, future studies should examine the effects of variables such skin pigmentation, environmental circumstances, and comorbidities. All things considered, clinical pallor is still a useful and accessible way to screen for anemia, especially in situations where laboratory tests are not available. This ensures that children who are at risk are identified early and can receive management.

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