Clinical Characteristics and Outcomes of Anemia in Critically Ill Patients: A Cross-Sectional Observational Study from a Tertiary Intensive Care Unit in Nepal

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ABSTRACT

Background

Anemia is a common clinical problem among critically ill patients; however, its prognostic significance remains debatable. In low-resource settings, such as Nepal, data are limited. This study evaluated the clinical, laboratory, and outcome profiles of anemia in a tertiary Intensive Care Unit.

Objective

To assess the clinical characteristics, laboratory features, and outcomes of anemia in critically ill patients admitted to a tertiary Intensive Care Unit in Nepal.

Method

This retrospective observational study included 113 adult Intensive Care Unit patients with anemia admitted to Dhulikhel Hospital, Nepal, from October 2024 to March 2025 after obtaining ethical approval from the Institutional Review Committee, Kathmandu University School of Medical Sciences (IRC, KUSMS-156/25). Demographic data, anemia severity, laboratory markers, including peripheral blood smear (PBS), and outcomes, such as mortality and Intensive Care Unit stay, were analyzed using IBM SPSS Statistics version 25.0. Categorical variables were compared with Chi-square tests, continuous variables with independent t-test or Mann-Whitney U test, and correlations were assessed with Spearman's rank method.

Result

The median hemoglobin level was 97 g/L (78-112g/L), and mild anemia was the most common (49.5%). Mortality correlated strongly with abnormal peripheral blood smear ($p < 0.001$, $r = 0.52$) and moderately with older age ($p = 0.012$, $r = 0.35$). Although anemia severity was not statistically significant ($p = 0.423$), its weak positive correlation ($r = 0.15$) indicates a potential trend.

Conclusion

Peripheral blood smear abnormalities and advanced age strongly predict mortality in critically ill patients, while anemia severity alone does not. Routine smear use in resource-limited ICUs may aid early risk stratification and improve care.

KEY WORDS

Anemia, Critical Illness, Intensive care unit, Nepal

INTRODUCTION

Approximately one-third of people worldwide suffer from anemia, characterized by a decreased hemoglobin or red blood cell count. Its prevalence is high in developing nations like Nepal.[1,2] It appears early in critically ill patients because of erythropoiesis impairment, nutritional deficiencies, inflammation, and bleeding.[3,4] Over 90% of ICU patients experience anemia within the first week, and roughly two-thirds are anemic upon admission.[5] There is disagreement regarding its prognostic value; some research links low hemoglobin to ICU stays, organ failure, and death, while other research sees it as a sign of the severity of the illness rather than a direct contributor to poor outcomes.[6-8]

Despite being a common treatment, blood transfusions carry risks like immunomodulation, infection, and fluid overload.[9] Unless there is active bleeding or comorbidities, guidelines advise strict transfusion thresholds for stable patients, i.e, typically hemoglobin < 70 g/L. Peripheral blood smear (PBS), reticulocyte count, iron studies, and inflammatory markers are necessary for evaluating anemia in the intensive care unit.[10,11] PBS abnormalities could be a sign of myelodysplastic syndromes, hemolysis, cancer, or other severe hematologic disorders.

Understanding the prognostic implications of anemia is essential for focused management and resource optimization in resource-constrained environments like Nepal, where transfusion and intensive care facilities are limited. ICU anemia has not been evaluated in many South Asian studies using both laboratory and outcome-based classifications. The purpose of this study was to determine the causes of anemia in Dhulikhel Hospital ICU patients and evaluate relationships between the severity of anemia and clinical outcomes.

METHODS

This was a retrospective observational cross-sectional study conducted in the Intensive Care Unit (ICU) of Dhulikhel Hospital, a tertiary care teaching hospital. The study period extended from October 2024 to March 2025. A total of 113 adult patients with anemia admitted to the ICU during this time were included, using a total enumeration sampling method.

A structured proforma was used to extract data from the hospital's electronic medical records. Demographic information like age and gender, clinical information like comorbidities, length of stay in the intensive care unit, history of transfusions, and mortality, and laboratory data like hemoglobin, hematocrit, serum iron, ferritin, total iron-binding capacity, C-reactive protein, and reticulocyte count were all data that were gathered. Peripheral blood smear findings were categorized as normal or abnormal, and anemia severity was graded according to the World Health Organization (WHO) classification into mild, moderate, and severe.

Ethical approval for this study was obtained from the Institutional Review Committee of Kathmandu University School of Medical Sciences (approval number 156/25). As this was a retrospective review of anonymized patient records, informed consent was not required. Patients aged 18 years or older with anemia admitted to the ICU during the study period were eligible for inclusion. Those with known hemoglobinopathies, pregnant women, and patients with an ICU stay of less than 24 hours were excluded.

All patients were managed according to standard ICU protocols, and anemia severity was classified following WHO guidelines. Statistical analysis was performed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean with standard deviation or median with interquartile range. Associations between variables were assessed using Chi-square and independent t-tests or Mann–Whitney U tests as appropriate, with a p-value of less than 0.05 considered statistically significant. For correlation analysis, we used Spearman's rank correlation because several variables did not follow a normal distribution.

RESULTS

A total of 113 critically ill patients with anemia were enrolled in this study. The cohort had a mean age of 58.5 years (± 16.9), with a male predominance. The median hemoglobin concentration at the time of admission was 97 g/L, with an interquartile range of 78 to 112 g/L. Based on the World Health Organization (WHO) anemia classification, nearly half of the patients presented with mild anemia, highlighting a substantial proportion of the cohort with less severe hemoglobin deficiency at baseline. Additionally, the majority of patients harbored at least one pre-existing comorbidity, reflective of the complex clinical profiles typical in a critically ill population. Detailed baseline clinical features and laboratory parameters are comprehensively summarized in table 1.

Outcome analyses were confined to patients with complete follow-up data (n = 44). Non-survivors were significantly older than survivors (66.1 vs. 50.1 years, $p = 0.012$), and Spearman's analysis showed a moderate positive correlation between age and mortality ($r \approx 0.35$), suggesting age as a key determinant of mortality risk. Peripheral blood smear abnormalities demonstrated a strong correlation with mortality ($r \approx 0.52$, $p < 0.001$). As illustrated in figure 1, all recorded deaths occurred exclusively in patients exhibiting abnormal peripheral blood smears, whereas none of the patients with normal smears experienced fatal outcomes. This finding underscores the potential prognostic value of peripheral smear abnormalities in critically ill anemic patients.

Evaluation of mortality stratified by anemia severity is shown in figure 2. Although mortality appeared higher in

Table 1. Baseline Clinical and Laboratory Characteristics of Patients with Anemia (n = 113)

Characteristics	Median (IQR) or Mean ± SD	Non-survivors	Survivors	p-value	Spearman's r with Mortality	Interpretation*
Age, years	58.5 (45.0–72.0)	66.1 (60.0–74.0)	50.1 (40.0–60.0)	0.012	0.35	Moderate (+)
Hemoglobin, g/L	97 (78–112)	60 (50–104)	83 (67.5–100)	0.282	-0.15	Weak (-)
Pre-existing conditions, n	1 (0–2)	1 (1–3)	1 (0–2)	0.571		
Transfusion units, n	1 (0–2)	1 (0–2)	0 (0–2.75)	0.711	0.08	Negligible
ICU stay, days	2 (2–4)	3 (2–6)	2 (1–3)	0.093	0.20	Weak (+)
Hematocrit, %	26.3 (22–30)	22.1 (18–25)	25.0 (20–29)	0.182	-0.18	Weak (-)
Reticulocyte count, %	0.7 (0.6–1.1)	0.7 (0.3–**)	0.7 (0.6–1.05)	0.663	0.05	Negligible
Serum iron, µg/dL	48.3 (30–65)	24.0 (18–35)	49.7 (32–68)	0.303	-0.22	Weak (-)
CRP, mg/L	37 (12–65.25)	70 (70–70)	15 (10–**)	0.667	0.12	Weak (+)

Note: Data are expressed as median (interquartile range, IQR) unless otherwise indicated. *Interpretation based on Cohen's guideline: 0.10–0.29 = weak, 0.30–0.49 = moderate, ≥ 0.50 = strong correlation. (+ = positive correlation, – = negative correlation). **Upper quartile could not be computed due to data distribution.

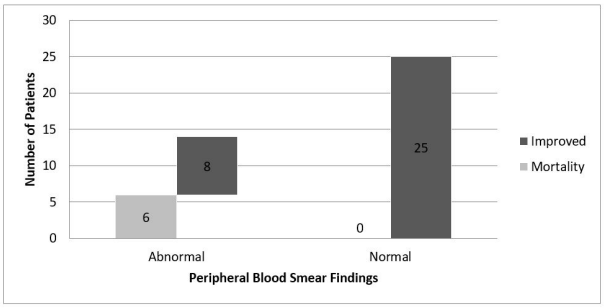

Figure 1. Outcome distribution according to peripheral blood smear findings

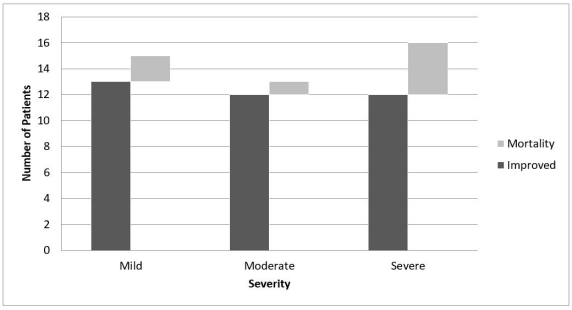

Figure 2. Outcome distribution according to severity of anemia

Table 2. Categorical clinical characteristics of patients according to outcome

Characteristic	Total n (%)	Mortality n (%)	Survival n (%)	p-value	Spearman's r with Mortality	Interpretation*
Severity of Anemia				0.423	0.15	Weak (+)
– Mild (Hb 110–129/119 g/L)	51 (49.5)	2 (13.3)	13 (86.7)			
– Moderate (Hb 80–109 g/L)	28 (27.2)	1 (7.7)	12 (92.3)			
– Severe (Hb <80 g/L)	24 (23.3)	4 (25.0)	12 (75.0)			
Gender				0.665	0.06	Negligible
– Male	64 (57.7)	4 (13.8)	25 (86.2)			
– Female	47 (42.3)	3 (21.4)	11 (78.6)			
Peripheral Blood Smear				0.001	0.52	Strong (+)
– Abnormal	28 (44.4)	6 (42.9)	8 (57.1)			
– Normal	35 (55.6)	0 (0.0)	25 (100.0)			
Sepsis				0.590	0.10	Weak (+)
– Yes	7 (21.9)	2 (28.6)	5 (71.4)			
– No	25 (78.1)	4 (16.0)	21 (84.0)			
Drug Therapy				0.567	0.09	Negligible
– Yes	6 (15.0)	0 (0.0)	6 (100.0)			
– No	34 (85.0)	7 (20.6)	27 (79.4)			

Note: Percentages are calculated by row for outcome columns. *Interpretation based on Cohen's guideline: 0.10–0.29 = weak, 0.30–0.49 = moderate, ≥ 0.50 = strong correlation.

patients with severe anemia, the association was weak (r ≈ 0.15, p = 0.423) and did not reach statistical significance. Thus, anemia severity at presentation, defined by hemoglobin concentration, did not independently predict mortality. Other characteristics, including sex, inflammatory marker levels, and transfusion history, showed only weak or negligible correlations with outcome (Table 2).

Collectively, these findings indicate that while age and peripheral blood smear abnormalities are important

predictors of mortality in critically ill patients with anemia, anemia severity per se and other examined clinical variables do not demonstrate independent prognostic utility in this specific population.

DISCUSSIONS

This study highlights the high prevalence of anemia among critically ill patients admitted to the ICU in a Nepalese tertiary hospital, with nearly half presenting with mild anemia. This observation is consistent with prior multinational studies that report anemia as a common comorbidity in ICU populations worldwide, particularly in low- and middle-income countries (LMICs) where nutritional deficiencies and a high burden of chronic illnesses are prevalent.[1,2,12]

A key finding was that anemia severity, as defined by WHO hemoglobin-based criteria, did not independently predict mortality. This adds to the growing body of evidence that the absolute hemoglobin concentration may not be as good of a predictor of how sick someone is as previously thought.[9,12] In this case, anemia is more likely to be a biomarker that shows the underlying systemic inflammatory state, disease burden, and organ dysfunction that goes along with it, rather than a direct cause of bad outcomes.[13,14] This underscores the contemporary clinical necessity to evaluate a more extensive range of clinical and laboratory indicators when determining prognosis in ICU patients.

In contrast, two factors emerged as significant and independent predictors of mortality: advanced age and abnormal peripheral blood smear (PBS) findings. The finding that older patients demonstrated worse outcomes is consistent with global ICU data, which identifies diminished physiological reserves, a higher prevalence of comorbidities, and an altered immune response (immunosenescence) as key contributors to poor prognosis in elderly critically ill patients.[15,16] This underscores the critical importance of age-adjusted risk stratification in the management of these populations.

The strong association between abnormal PBS findings and mortality represents one of the most significant contributions of this study. Morphological abnormalities on a PBS are a low-cost yet high-yield diagnostic tool that may indicate underlying pathological processes such as hemolysis, marrow suppression, micronutrient deficiencies, or severe inflammation, all of which are intrinsically linked to adverse outcomes.[17,18] Recent work has corroborated the value of PBS, demonstrating that remote interpretation of smear morphology can significantly improve diagnostic accuracy in resource-limited settings.[19] Given its affordability and accessibility, we strongly advocate for the routine incorporation of PBS evaluation into the standard diagnostic workup for anemic patients in resource-constrained ICUs, where access to more advanced and expensive hematological tests is often limited.

Interestingly, neither transfusion practices nor single measurements of inflammatory markers such as C-reactive protein were significantly associated with mortality in our cohort. This aligns well with the restrictive transfusion strategies advocated by current international guidelines, which emphasize a threshold of 70 g/L for hemodynamically stable patients without active coronary disease.[11,20,21] It also underscores the complex, dynamic nature of systemic inflammation in critical illness, where single-point measurements of biomarkers may lack the sensitivity and specificity to reliably predict heterogeneous outcomes.[14,22]

Taken together, our findings suggest that while anemia is almost universal in critically ill patients, its severity is not an independent predictor of mortality. Instead, age and peripheral blood smear abnormalities appear to have greater prognostic significance. From a clinical perspective, integrating these simple, readily available parameters into routine ICU evaluation could help identify high-risk patients early, enabling more targeted and intensive management strategies. From a public health perspective, enhancing local capacity for basic, low-cost hematological evaluations such as PBS could significantly strengthen critical care delivery in LMICs like Nepal.

Future large-scale, multicenter prospective studies are warranted to validate these findings and to develop robust prognostic models that integrate these clinical and laboratory markers for improved risk stratification in ICU patients with anemia.

This study has certain limitations that should be acknowledged. The retrospective, single-centre design and the relatively small sample size limit the statistical power and generalizability of our findings, potentially introducing selection bias. Furthermore, the analysis of primary outcomes was confined to a smaller subset of patients due to incomplete follow-up data, which may further affect the validity and representativeness of the mortality analysis.

CONCLUSION

Advanced age is associated with a higher mortality rate, and patients with severe anemia have abnormal peripheral blood smear results. Routine PBS screening and age-adjusted clinical decision making may aid in early risk classification, especially in resource-constrained environments. A larger prospective study is required to validate these findings and enhance the management of anemia in critically ill patients.

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