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Outcomes on Hospital Discharge of Patients with Subtypes of Anemia. an Analytical Retrospective Study on Mortality and Length of Stay

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Abstract **Original Research Article**

The global prevalence of anemia affects approximately 33% of the world's population, equivalent to more than 2 billion people, and is more common in women and children. Years of life lost due to anemia could not be calculated because mortality could not be attributed to anemia; however, improvements in the treatment of hemoglobin disorders have decreased mortality rates among affected children under 5 years of age. (17) Other studies indicate that anemia worsens the prognosis of patients presenting to the emergency department. Among 99 patients with anemia, 36.37% were hospitalized for clinical reasons. Furthermore, anemia in critically ill patients was associated with increased mortality, longer hospital stays, and a greater need for red blood cell transfusions. ***Objective:*** To quantify the differences between anemia subtypes in all-cause in-hospital mortality, and length of hospital stay using bivariate analyses. ***Method:*** This retrospective, cross-sectional/cohort observational study used routinely collected hospital discharge data (2019–2025) from University Hospital, a tertiary care referral. ***Results:*** This study included 5,332 patients hospitalized, between January 2019 and August 2025. To be eligible, participants had to have at least one diagnosis of anemia, according to the International Classification of Diseases. A total of 56 deaths were reported, with an overall mortality rate of 1.1%, while the average length of stay was 9.22 days (95% CI: 8.93–9.51). ***Conclusion:*** Analysis of this population demonstrated a significantly higher mortality rate in patients with aplastic anemias and other anemias due to bone marrow failure compared to other hospitalized patients with anemia.
Keywords: Inpatients, Anemia, Mortality, Length of Stay.

INTRODUCTION

The WHO defines anemia as a condition in which the concentration of hemoglobin in the blood is below the levels considered normal for a given age, sex, and physiological state, resulting in a reduced capacity of the body to transport oxygen. [1]

The global prevalence of anemia affects approximately 33% of the world's population, equivalent to more than 2 billion people, and is more common in women and children. Some developing countries, particularly in Africa and South America, have higher rates, and in certain countries, such as Nigeria, India, and Bangladesh, prevalence rates exceeding 50% have been reported in some groups. [2,3]

"The global prevalence of anemia in 2010 was 32.9%"; iron deficiency anemia was the leading cause worldwide. Malaria, schistosomiasis, and anemia related to chronic kidney disease were the only conditions whose prevalence increased. [3]

The most common types of anemia are:

- Iron deficiency anemia: This is the most common form and is caused by insufficient iron intake, malabsorption, or excessive iron loss. [4]
- Megaloblastic anemia: This is generally caused by deficiencies in vitamin B12 and folic acid, which affect red blood cell production. [5]
- Some anemias are more common in certain countries or racial groups due to genetic, cultural, or socio-economic factors. Some examples are:
- Sickle cell anemia: Common in African, Mediterranean, and African-descended populations due to a genetic mutation in hemoglobin. [6]

- Thalassemia anemia: Prevalent in regions of the Mediterranean, the Middle East, Africa, and Asia, caused by defects in hemoglobin production. [7]
- Hereditary spherocytic anemia is a genetic disorder characterized by the presence of spherical and fragile red blood cells. It is more common in specific European populations, particularly among people of Mediterranean descent, including those of Italian, Spanish, and Greek ancestry. [8,9]
- The most common anemias in the United States are:
- Iron deficiency anemia: This is the most common cause of anemia in the general population and primarily affects women of reproductive age, children, and older adults.
- Anemia of chronic disease: This is common in people with chronic illnesses such as kidney failure, cancer, or inflammatory diseases.
- Vitamin B12 and folate deficiency anemia: This is more common in older adults and in people with nutritional or absorption problems. [10,11]
- The diseases most frequently associated with anemia include:
- Chronic inflammatory and infectious diseases (such as tuberculosis, HIV/AIDS, and malaria), which can affect the production or survival of red blood cells. [12]
- Chronic kidney disease, which leads to decreased production of erythropoietin, a hormone necessary for red blood cell production. [13] Cancer and its treatment can cause anemia due to bone invasion, bleeding, or the effects of chemotherapy. Autoimmune diseases (such as systemic lupus erythematosus) can trigger hemolytic or inflammatory anemia. [14] Nutritional deficiencies (iron, vitamin B12, or folate) are important causes of anemia. [10,11] According to data from the World Health Organization and recent studies, anemia is a leading cause of hospitalization in low- and middle-income countries; however, there is no precise, unified global percentage due to differences in health systems and epidemiological records. Nevertheless, anemia is recognized as a factor that increases morbidity, mortality, and hospital length of stay. [15] Mortality rates from atrial fibrillation and anemia increased significantly between 1999 and 2023. Crucial disparities were observed across demographic and geographic strata. Rural areas had a higher average than urban areas. [16]

Years of life lost due to anemia could not be calculated because mortality could not be attributed to anemia; however, improvements in the treatment of hemoglobin disorders have decreased mortality rates among affected children under 5 years of age. [17] Other studies indicate that anemia worsens the prognosis of patients presenting to the emergency department. Among 99 patients with anemia, 36.37% were hospitalized for clinical reasons. [18]

Furthermore, anemia in critically ill patients was associated with increased mortality, longer hospital stays, and a greater need for red blood cell transfusions. [19, 20]

Anemia is a common cause of heart failure and is associated with reduced functional capacity, increased mortality, and morbidity rates. [21]

OBJECTIVES

To quantify the differences between anemia subtypes in all-cause in-hospital mortality, and length of hospital stay using bivariate analyses.

METHODS

This retrospective, cross-sectional/cohort observational study used routinely collected hospital discharge data (2019–2025) from the Dr. José Eleuterio González University Hospital, a tertiary care referral hospital in Monterrey, Mexico, serving a predominantly Latino population of low to- middle income status. Our study included all discharges with at least one diagnosis of anemia and related disorders, according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10). The study design and reporting followed the STROBE-RECORD guidelines for observational studies using routinely collected health data. No additional data collection or follow-up was performed.

This research examined the association between anemia subtypes, as classified by ICD-10, and all-cause in-hospital mortality and length of hospital stay. An analysis was also conducted of demographic variations, specifically age and sex.

Anemia diagnoses were classified into the following mutually exclusive groups, using pre-specified ICD-10 codes (D50-D64):

- Iron deficiency anemia (D50)
- Other nutritional anemias (D51-D53) (as defined by the WHO)
- Hemolytic anemias (D55-D59)
- Aplastic anemias and other anemias due to bone marrow failure (D60-D61)
- Acute post-hemorrhagic anemia (D62)
- Anemia of chronic disease (D63)
- Other specified anemias (D64, excluding D64.9)
- Unspecified anemia (D64.9)

Reclassification of D64.9, which lacks etiological specificity, required a secondary rule-based approach, using ICD-10 comorbidities. (Codes documented during admission.)

Reclassification was only permitted when a specific etiology could be inferred from objective coding data, following these criteria:

1. Initial reclassification if another type of anemia was specified. 2. Subsequently, reclassification of unspecified anemia to iron deficiency anemia, based on the presence of the following diagnoses:

- Iron deficiency (E61.1)
- D50.x as a secondary code (if present along with D64.9)
- Gastrointestinal angiodysplasia (e.g., K55.2, equivalent to K31.811/K31.819)
- Peptic ulcers with chronic or unspecified bleeding (K25.4–K25.6; K26.4–K26.6; K27.4–K27.6; K28.4–K28.6)
- Bleeding hemorrhoids (K64.0–K64.2, K64.4)
- Chronic gastrointestinal bleeding in diverticulosis or adenomas, when documented as bleeding
- Heavy menstrual bleeding (N92.0–N92.4)
- Chronic gynecologic bleeding due to structural causes (D25.x, N85.0, N93.x)
- Chronic epistaxis (R04.0)
- Hereditary hemorrhagic telangiectasia (I78.0)
- Non-acute hemorrhagic diatheses (D66–D68, D69.2–D69.3)

3. Acute post-hemorrhagic anemia: Cases coded as D64.9 with coexisting codes indicative of acute hemorrhage (e.g., gastrointestinal bleeding, ulcerative hemorrhage, acute uterine hemorrhage, postpartum hemorrhage, esophageal variceal hemorrhage, or documented hemorrhage, such as R58) were reassigned to Group 5.

4. Anemia of chronic disease: Cases coded as D64.9 were reassigned to Group 6 if comorbidities associated with anemia of chronic disease were coded. These include chronic kidney disease (N18-N19), chronic inflammatory or autoimmune disorders (e.g., M05-M06, M32-M34, K50-K51), chronic infections (HIV B20-B24; tuberculosis A15-A19), malignancies (C00-C97), chronic liver disease (K70-K77), or chronic heart failure (I50).

Cases coded as D64.9 that did not meet any of the above criteria remained in Group 8 (Unspecified).

Descriptive analysis: The characteristics of patients with the different anemia subtypes were summarized using means and proportions, as appropriate, including their 95% confidence intervals. Mortality differences among the eight ICD-10 anemia subtypes were evaluated using bivariate analyses. Specifically, Pearson's chi-squared test was used, with Fisher's exact test used when expected counts were less than 5. Cramer's V values were used to report effect size. Post-hoc analyses, consisting of one-to-all comparisons using Pearson's chi-squared test, were performed after any significant omnibus test result.

For continuous outcomes (e.g., length of hospital stay): Differences between groups were assessed using one-way ANOVA. When the homoscedasticity assumption was violated, Welch's ANOVA was used. Effect size was reported as η^2 (or ε^2). Post hoc analyses were performed when the omnibus test indicated a significant difference.

For all exploratory pairwise comparisons (post-hoc tests), the Benjamini-Hochberg false discovery rate (FDR) procedure was applied to correct for multiplicity. Results were interpreted descriptively, reporting effect sizes, 95% confidence intervals (CIs), p-values, and FDR-corrected q-values. All variables were fully observed; no missing data were identified, so imputation and case exclusion were not required.

Analyses were performed using Python 3.13.7, with the NumPy, SciPy, and Matplotlib libraries. Syntax files and data definitions are available upon request.

RESULTS

This study included 5,332 patients hospitalized at the José Eleuterio González University Hospital in Monterrey, Nuevo León, Mexico, between January 2019 and August 2025. To be eligible, participants had to have at least one diagnosis of anemia, according to the International Classification of Diseases, 10th Revision (ICD-10), whose codes begin with the letter "D". The study included 5,332 hospitalizations for anemia (ICD-10: D50-D89). The mean age was 54 years (SD: varies by group, range 1-90+ years), with the following age distributions: <10 years (n = 230, 4.3%), 10-20 years (n = 299, 5.6%), 21-30 years (n = 577, 10.8%), 31-40 years (n = 710, 13.3%), 41-50 years (n = 982, 18.4%), 51-60 years (n = 1,039, 19.5%), 61-70 years (n = 782, 14.7%), 71-80 years (n = 486, 9.1%), 81-90 years (n = 198, 3.7%) and ≥90 years (n = 29, 0.5%). The sample consisted of 47% men (n = 2504) and 53% women (n = 2828). (Table 1).

Table 1: Distribution of patients by age

AGE	n %
<10 years	(n=230, 4.3%)
10-20 years	(n=299, 5.6%)
21-30 years	(n=577, 10.8%)
31-40 years	(n=710, 13.3%)
41-50 years	(n=982, 18.4%)
51-60 years	(n=1,039, 19.5%)
61-70 years	(n=782, 14.7%)
71-80 years	(n=486, 9.1%)
81-90 years	(n=198, 3.7%)
≥90 years	(n=29, 0.5%)

Eight types of anemia were identified: anemia of chronic disease (n = 1970, 37%), unspecified anemia (n = 1446, 27%), iron deficiency anemia (n = 472, 9%), other specified anemias (n = 571, 11%), aplastic anemias due to bone marrow failure (n = 267, 5%), acute post-hemorrhagic anemia (n = 323, 6%), hemolytic anemias (n = 114, 2%), and other nutritional anemias (n = 169, 3%).

The main comorbidity categories included heart disease, kidney disease, liver disease, malignancies, and infectious diseases, although specific prevalence rates were fragmented across numerous combinations, limiting the analysis of comorbidities.

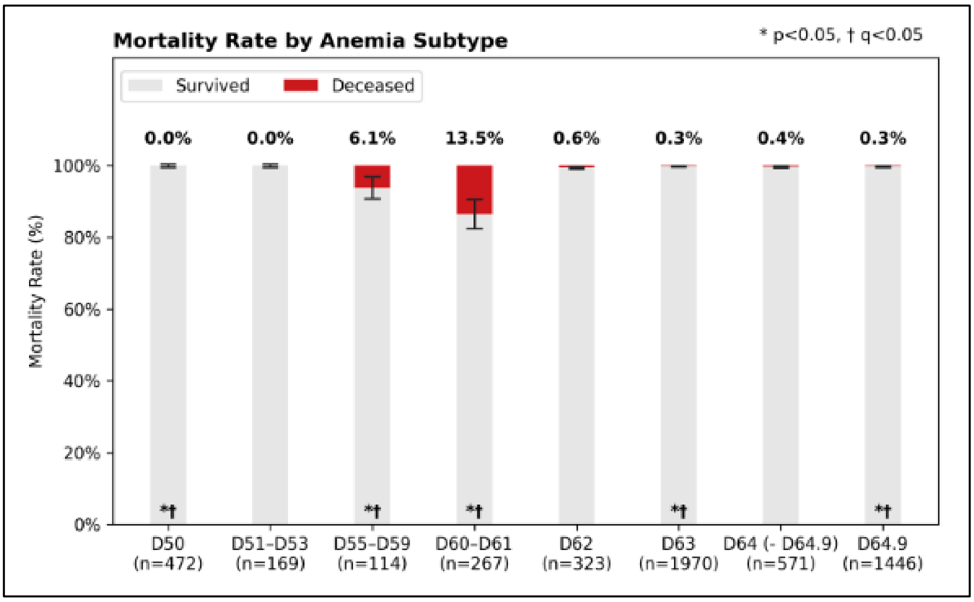
Anemia of chronic disease (D63) was the most frequently observed subtype, representing 36.95% (n = 1,970) of all cases. This was followed by unspecified anemia (D64.9) at 27.12% (n = 1,446) and other specified anemias (D64, excluding D64.9) at 10.71% (n = 571). The breakdown by sex revealed that unspecified anemias were more prevalent in women (49.6%) than in men (39.7%).

MORTALITY

A total of 56 deaths were reported, with an overall mortality rate of 1.1%, while the average length of stay was 9.22 days (95% CI: 8.93–9.51).

Mortality rate by anemia subtype.

The bar heading corresponds to each ICD-10 anemia category: D50, Iron deficiency anemia; D51–53, Other nutritional anemias; D55–D59, Hemolytic anemias; D60–D61, Aplastic anemias and other anemias due to bone marrow failure; D62, Acute post-hemorrhagic anemia; D63, Anemia of chronic disease; D64 except D64.9, Other anemias; D64.9, Unspecified anemia. *p < 0.05, †q < 0.05. (Figure 1)



Graphic 1: Mortality by Anemia Subtype

Analysis of individual vs. overall mortality by anemia subtype. Chi-square/Fisher's exact tests were used. Relative risk (RR) compares the probability of mortality between groups. Cramer's V measures the magnitude of the association: 0.00–0.10 negligible, 0.10–0.20 small, 0.20–0.30 small-to-medium, 0.30–0.40 medium-to-large, and ≥0.40 large. The Benjamini-Hochberg procedure controlled for the false-positive rate (α = 0.05). (Table 2)

Table 2: Type of Anemia and mortality

Anemia Type	Deaths/n (%)	RR	95% CI	p-value	Cramér's V	Effect Size
Iron deficiency (D50)	0/472 (0%)	0.09	0.01–1.47	0.008	0.032	Negligible
Other nutritional (D51-D53)	0/169 (0%)	0.27	0.02–4.33	0.424	0.019	Negligible
Hemolytic (D55-D59)	**7/114 (6.1%)**	**6.54**	**3.03–14.12**	**<0.001**	**0.074**	**Small-to-medium**
Aplastic/marrow failure (D60-D61)	**36/267 (13.5%)**	**34.15**	**20.05–58.16**	**<0.001**	**0.280**	**Small-to-medium**
Acute posthemorrhagic (D62)	2/323 (0.6%)	0.57	0.14–2.35	0.774	0.011	Negligible
Anemia of chronic disease (D63)	5/1970 (0.3%)	0.17	0.07–0.42	<0.001	0.060	Negligible
Other specified (D64 except D64.9)	2/571 (0.4%)	0.31	0.08–1.26	0.123	0.024	Negligible
Unspecified (D64.9)	4/1446 (0.3%)	0.21	0.07–0.57	<0.001	0.046	Negligible

Aplastic/bone marrow failure anemias showed the strongest association with in-hospital mortality, indicated by a high RR of 34.15 (95% CI, 20.05–58.16) and a medium effect size. Other subtypes, although statistically significant, showed negligible associations, suggesting that mortality is largely independent of their classification. As shown in Figure 1, hemolytic anemias also showed a marked increase in mortality (RR = 6.54; 95% CI, 3.03–14.12), but further analysis revealed that the effect size was negligible. This demonstrates that, for most anemia subtypes, other factors play a more significant role in in-hospital mortality.

HOSPITAL STAY

Among the demographic and clinical variables examined, anemia type and age range showed statistically significant associations with length of hospital stay; however, both variables explained only a minimal proportion of the variation in length of hospital stay.

Anemia type ($p < 0.01$, $\eta^2 = 0.0136$): Modest differences were observed; Aplastic/bone marrow failure anemias were associated with longer hospital stays (mean = 12.3 days) compared with iron deficiency anemia (mean = 7.3 days). This variable explained approximately 1.4% of the variation in length of hospital stay (LHS). Age range ($p < 0.01$, $\eta^2 = 0.0160$): Younger patients had longer hospital stays (ages 1–10: mean = 13.8 days) than older patients (ages 90+: mean = 6.0 days), accounting for approximately 1.6% of the variation in length of hospital stay. (Table 3)

Table 3: Mean length of stay in and 95% confidence intervals by Anemia subtype

Anemia Subtype	n	Mean LOS (days)	95% CI
Iron deficiency anemia (D50)	472	7.30	6.44–8.16
Unspecified anemia (D64.9)	1,446	8.24	7.70–8.78
Acute posthemorrhagic anemia (D62)	323	8.28	7.15–9.40
Hemolytic anemias (D55–D59)	114	8.96	7.40–10.53
Anemia of chronic disease (D63)	1,970	9.39	8.92–9.86
Other nutritional anemias (D51–D53)	169	10.96	8.93–12.98
Other specified anemias (D64 except D64.9)	571	10.98	10.12–11.83
Aplastic/marrow failure anemias (D60–D61)	267	12.32	10.76–13.89

LOS: hospital length of stay.
CI: Confidence interval.

Gender ($p < 0.01$, $\eta^2 = 0.0084$): The association was statistically significant, but had a negligible practical effect. Men had an average hospital stay 1.9 days longer than women, with an eta-squared statistic ($\eta^2 = 0.0084$) indicating that gender explained only 0.8% of the variance in length of hospital stay.

DISCUSSION

Matzner reports chronic kidney failure, metastatic carcinoma, gastrointestinal bleeding, and infections. These reports are similar to our findings. [22] Bashir reports that anemia significantly increases mortality in hospitalized patients regardless of the cause. [23] Yusuf reports that hospitalized patients with anemia have associated morbidities such as chronic kidney disease, infections, and liver disease, among others. [24] Aplastic anemias and other anemias associated with bone marrow failure, along with hemolytic anemias, were the two anemia categories associated with statistically significant increases in mortality rates compared to other types.

Specifically, the mortality rate reached 13.5% ($p<0.01$, $q<0.01$) for aplastic anemias and other anemias due to bone marrow failure and 6.1% ($p<0.01$, $q<0.01$) for hemolytic anemias.

Wangping reports significant mortality in hospitalized patients with anemia compared to patients without anemia, especially female patients [25]. Desmond *et al.,* indicate that mortality in this population is related to the direct clinical consequences of these cytopenias: life-threatening bleeding due to thrombocytopenia and serious infections resulting from neutropenia. While nutritional anemias showed benign outcomes, the high risk of mortality in the aplastic anemia group suggests that anemia can be used as a marker of severe systemic instability [26]. This highlights the importance of optimal identification to prioritize resource allocation to subgroups of patients at higher risk of deterioration.

Although anemia subtype, age range, and sex showed statistically significant associations with length of hospital stay, their practical impact is negligible given their magnitudes.

CONCLUSION

Analysis of this population demonstrated a significantly higher mortality rate in patients with aplastic anemias and other anemias due to bone marrow failure compared to other hospitalized patients with anemia. While not exhaustive, these findings are well explained by the natural history of the disease in this subgroup of anemias.

Limitations

The study's limitations include reduced external validity due to a non-probabilistic, consecutive sampling method confined to a single tertiary public hospital in Monterrey, Mexico, and a patient profile predominantly from a lower-middle socioeconomic background, which may not be generalizable to other healthcare settings. The use of administrative data introduces further limitations, restricting operationalization and increasing the possibility of misclassifying anemia subtypes, in addition to the challenge of unmeasured physiological severity.

Furthermore, data collection spanned a seven-year period from 2019 to 2025. While this duration helps mitigate the effect of short-term seasonality, it is important to note that this period includes high-impact public health events, such as the COVID-19 pandemic. This event could have altered hospitalization patterns, the etiology of anemia, and the profile of admitted patients.

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