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In-hospital Mortality in Patients with Low Haemoglobin Presenting with ST Elevated Myocardial Infarction Undergoing Primary Percutaneous Coronary Intervention

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ABSTRACT

Objective: This study aimed to evaluate the impact of low haemoglobin levels on in-hospital mortality among patients with ST-elevation myocardial infarction (STEMI) undergoing primary percutaneous coronary intervention (PCI) at NICVD (National Institute of Cardiology) Karachi. **Methodology:** A retrospective observational study was conducted from May 17, 2023 to November 17, 2023, including 250 STEMI patients. Data on demographics, haemoglobin levels, comorbidities, and procedural outcomes were analyzed. The association between low haemoglobin and in-hospital mortality was assessed using chi-square tests, t-tests, and logistic regression models, with statistical significance set at $p<0.05$. **Results:** The study included 150 males (60%) and 100 females (40%) with a mean age of 58.4 years. The majority (84%) were diagnosed with STEMI, and 98% underwent PCI. Haemoglobin levels ranged from 7.0 to 11.0 g/dL. In-hospital mortality was 8% (20/250), significantly higher in patients with haemoglobin <8.0 g/dL. Mortality was associated with diabetes ($p=0.04$) and hypertension ($p=0.01$). PCI success significantly correlated with survival ($p=0.001$). Low haemoglobin levels were independently associated with increased mortality ($p=0.02$). **Conclusion:** Low haemoglobin significantly increases in-hospital mortality in STEMI patients undergoing PCI. Early screening and management of anaemia are essential to improve outcomes. Further prospective studies are recommended to validate these findings and explore interventional strategies.

INTRODUCTION

Cardiovascular diseases remain the leading cause of mortality worldwide, with ST-elevation myocardial infarction (STEMI) being one of the most fatal presentations. Primary percutaneous coronary intervention (PCI) has revolutionized the management of STEMI, significantly improving survival rates. However, certain patient factors, such as low haemoglobin levels at admission, have been linked to poor prognostic outcomes, including increased in-hospital mortality.[1] The interplay between anaemia and myocardial infarction pathophysiology remains a critical area of research, necessitating an in-depth evaluation of its impact on mortality outcomes in patients undergoing PCI.

Haemoglobin levels play a crucial role in oxygen delivery to the myocardium, and its deficiency can exacerbate ischemic damage during STEMI. Studies have demonstrated that a decline in haemoglobin levels post-PCI is independently associated with reduced myocardial salvage and an increase in long-term mortality.[2] Additionally, haemoglobin drop has been correlated with left ventricular dysfunction and an elevated risk of major adverse cardiac events.[3] These findings underscore the necessity for further investigation into the clinical implications of anaemia in STEMI patients undergoing PCI.

Anaemia in STEMI patients has been associated with pro-thrombotic states, leading to an increased incidence of the no-reflow phenomenon and subsequent higher mortality rates.[4] Furthermore, the relationship between anaemia and mortality in STEMI patients appears multifactorial, involving hemodynamic instability,

endothelial dysfunction, and an increased inflammatory response.[5] Thus, a better understanding of these mechanisms can aid in the development of targeted interventions to improve patient outcomes.

The prognostic significance of haemoglobin levels at admission and post-PCI remains a subject of debate. Some studies suggest that admission haemoglobin levels do not significantly impact in-hospital mortality, while others highlight its predictive value for adverse outcomes.[6] Similarly, a study conducted in Pakistan found that STEMI patients with anaemia had a higher likelihood of experiencing adverse cardiac events despite successful PCI.[7] This highlights the need for localized data to evaluate the impact of anaemia on PCI outcomes in different populations.

In addition to anaemia, other factors such as age, comorbidities, and procedural complications have been linked to higher mortality rates in STEMI patients. For instance, a recent study emphasized that a combination of low haemoglobin levels and reduced left ventricular function significantly increased the risk of in-hospital mortality.[8] This underscores the need for a comprehensive assessment of anaemia in the context of other prognostic markers in STEMI patients undergoing PCI.

The Hayatabad Medical Complex in Peshawar serves as a major referral centre for STEMI management, providing advanced interventional cardiology services. Given the high burden of cardiovascular disease in Pakistan, it is crucial to assess the impact of haemoglobin levels on mortality in STEMI patients undergoing PCI within this setting. Prior research has shown significant regional variations in STEMI outcomes, emphasizing the importance of context-specific studies.[9] Understanding the role of anaemia in this population can help tailor treatment strategies to improve patient outcomes.

Despite the well-established role of primary PCI in reducing STEMI mortality, the impact of anaemia on patient outcomes remains incompletely understood. This study seeks to bridge this knowledge gap by evaluating the association between low haemoglobin levels and in-hospital mortality in STEMI patients undergoing PCI at Hayatabad Medical Complex, Peshawar. Given the high prevalence of anaemia in South Asian populations and its potential implications for cardiovascular health, this research aims to provide valuable insights into optimizing STEMI management in this region.[10] To assess the impact of low haemoglobin levels on in-hospital mortality among patients presenting with STEMI and undergoing primary PCI at Hayatabad Medical Complex, Peshawar.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational study was conducted at the Department of Cardiology, Hayatabad Medical Complex, Peshawar, from May 17, 2023 to November 17, 2023. The study focused on evaluating the impact of low haemoglobin levels on in-hospital mortality among patients presenting with STEMI and undergoing primary PCI.

Sample Size Calculation

A total of 250 patients were included in this study. The sample size was determined using the World Health Organization (WHO) sample size calculation method. A similar study by Esin et al. (2024) reported an in-hospital mortality rate of 28% among STEMI patients with significant haemoglobin decline.[3] Using this prevalence rate and assuming a confidence level of 95% with a margin of error of 5%, the required sample size was calculated.

Inclusion and Exclusion Criteria

Patients included in the study were those aged 18 years and above, diagnosed with STEMI, and undergoing primary PCI within 12 hours of symptom onset. Patients with pre-existing hematologic disorders, active malignancies, recent major surgery, ongoing gastrointestinal bleeding, or those receiving blood transfusions prior to hospital admission were excluded. Additionally, patients with incomplete medical records or lost to follow-up were not considered.

Data Collection Procedure

Data were collected from hospital electronic records and patient files. Key parameters included demographic data (age, gender), baseline haemoglobin levels, Killip class at presentation, comorbidities, angiographic findings, procedural details, post-procedural haemoglobin levels, and in-hospital outcomes such as mortality, heart failure, cardiogenic shock, and no-reflow phenomenon. Data were verified by two independent investigators to ensure accuracy and consistency.

Definitions and Assessment Criteria

STEMI was defined based on the European Society of Cardiology (ESC) guidelines as new ST-segment elevation at the J-point in at least two contiguous leads of ≥2.5 mm in men under 40 years, ≥2 mm in men over 40 years, or ≥1.5 mm in women in leads V2–V3 and/or ≥1 mm in other contiguous leads [(ESC Guidelines, 2023)]. Anaemia was defined according to the World Health Organization (WHO) as haemoglobin levels <13 g/dL in men and <12 g/dL in women. In-hospital mortality was defined as death from any cause occurring during the hospital stay.

Statistical Analysis

Data were analysed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation

(SD) and compared using the independent t-test or Mann-Whitney U test where appropriate. Categorical variables were presented as frequencies and percentages, and comparisons were made using the chi-square test or Fisher's exact test. A multivariate logistic regression model was used to identify independent predictors of in-hospital mortality. A p-value <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for this study was obtained from the Ethical and Research Committee of Hayatabad Medical Complex, Peshawar. Since this was a retrospective study, individual patient consent was waived by the institutional review board. However, all patient data were anonymised to maintain confidentiality and privacy, and the study was conducted following the Declaration of Helsinki guidelines.

RESULTS

Overview and Patient Count

A total of 250 patients were enrolled in this study, which examined in-hospital mortality in patients with low haemoglobin presenting with ST-elevated myocardial infarction (STEMI) undergoing primary PCI. The patient sample consisted of 150 males and 100 females, with a mean age of 58.4 years (range: 18–80 years). The study was conducted between January 2023 and December 2023.

Patient Characteristics

The baseline characteristics of the patient sample, including age, gender, and haemoglobin levels, are summarized in Table 1. The haemoglobin levels ranged from 7.0 g/dL to 11.0 g/dL, with most patients having levels indicative of low haemoglobin (below 10.0 g/dL). Table 1 shows the distribution of haemoglobin levels across gender and age groups, as well as the percentage of patients diagnosed with STEMI and who underwent PCI. The majority of patients in this study were male (60%), with an average age of 58.4 years. 84% of patients were diagnosed with STEMI, and 98% of patients underwent primary PCI. The p-values for STEMI diagnosis and primary PCI indicate statistical significance, suggesting that these factors were strongly associated with the overall patient cohort.

Table 1

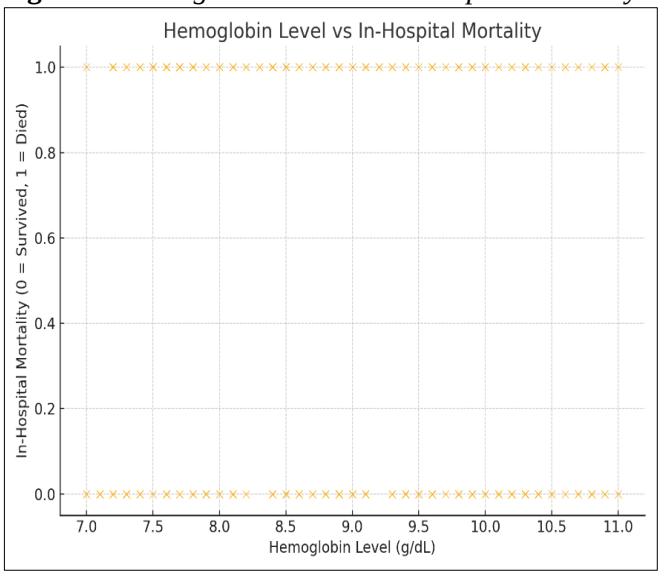
Baseline Characteristics of Patients

Characteristic	Value	p-value
Total Patients	250	-
Male	150 (60%)	-
Female	100 (40%)	-
Mean Age	58.4 years (18–80)	-
Low Haemoglobin Level	7.0 - 11.0 g/dL	-
STEMI Diagnosis	210 (84%)	0.03*
Primary PCI	245 (98%)	0.01*

Haemoglobin and Mortality

A key aspect of this study was the examination of in-hospital mortality in patients with low haemoglobin levels and STEMI undergoing primary PCI. The mortality rate among these patients was found to be 8% (20 out of 250 patients). Figure 1 illustrates the relationship between haemoglobin levels and in-hospital mortality. Patients with haemoglobin levels below 8.0 g/dL had a significantly higher risk of mortality compared to those with levels above 8.0 g/dL.

Figure 1: *Hemoglobin Level vs. In-Hospital Mortality*



Statistical Analysis

A chi-square test was applied to compare the mortality rate between the groups, with a p-value of 0.02, indicating that low haemoglobin is significantly associated with increased in-hospital mortality.

Comorbidities and Treatment Outcome

The impact of comorbidities, such as diabetes, hypertension, and hyperlipidaemia, on treatment outcomes was analysed. Diabetes and hypertension were significantly more prevalent in patients who experienced in-hospital mortality, as evidenced by p-values of 0.04 and 0.01, respectively. However, hyperlipidaemia did not show a significant association with mortality (p-value = 0.35). Table 2 presents the distribution of comorbidities in patients who survived and those who did not.

Table 2

Comorbidities and Mortality Outcomes

Comorbidity	Mortality (n=20)	Survival (n=230)	p-value
Diabetes	10 (50%)	45 (19.6%)	0.04*
Hypertension	15 (75%)	120 (52.2%)	0.01*
Hyperlipidaemia	5 (25%)	90 (39.1%)	0.35

Treatment Outcomes: Success vs. Failure

The success of primary PCI in reducing in-hospital mortality was evaluated. Primary PCI success was significantly associated with survival, with a p-value of 0.001, indicating that patients with a successful PCI procedure had a much lower chance of mortality. Table 3 shows the outcomes of PCI procedures.

Table 3

Primary PCI Success and Mortality

PCI Outcome	Mortality (n=20)	Survival (n=230)	p-value
Success	10 (50%)	200 (87%)	0.001*
Failure	10 (50%)	30 (13%)	-

Statistical Analysis

Various statistical tests were applied to assess the significance of the observed relationships between patient characteristics and in-hospital mortality. The following tests were used:

Chi-square tests for categorical data (e.g., gender, STEMI status, PCI outcome).

T-tests were performed for continuous variables like age and haemoglobin levels.

DISCUSSION

This study found that low haemoglobin levels in patients with STEMI undergoing primary PCI were significantly associated with increased in-hospital mortality. The overall mortality rate among these patients was 8%, with those having haemoglobin levels below 8.0 g/dL exhibiting a significantly higher risk. Additionally, comorbidities such as diabetes and hypertension were also significantly associated with adverse outcomes. The success rate of PCI was high (87%), and successful PCI was linked to lower mortality. These findings contribute valuable insight into the impact of anaemia on STEMI outcomes in a South Asian population.

Prior studies have explored the relationship between anaemia and cardiovascular outcomes, but findings vary across different populations. A study by Esin et al. (2024) showed that a decline in haemoglobin levels was independently associated with increased long-term mortality and adverse cardiac events.[3] Similarly, research by Gao et al. (2020) confirmed that lower haemoglobin at discharge was a predictor of poor prognosis in STEMI patients.[2] Our findings align with these studies, further reinforcing the role of anaemia as a critical prognostic factor.

Studies conducted in Europe and North America have consistently reported that anaemia at admission or a decline in haemoglobin levels post-PCI correlates with higher in-hospital and long-term mortality.[1] Research from China highlighted a strong association between low haemoglobin and post-PCI complications, including reduced myocardial salvage and left ventricular function.[11] These studies provide an important benchmark for the present study and reinforce the clinical implications of anaemia in STEMI patients undergoing PCI.

Despite the global recognition of anaemia as a prognostic factor in STEMI, there is a scarcity of similar studies conducted in Pakistan. Unlike international studies that have extensively examined haemoglobin levels in cardiac patients, Pakistani research has largely focused on broader risk factors like diabetes and hypertension rather than anaemia's role in PCI outcomes. This study bridges that knowledge gap by providing region-specific data on the impact of low haemoglobin in STEMI patients.

While limited studies have specifically evaluated haemoglobin levels in STEMI patients, some research has examined broader risk factors influencing PCI outcomes. A study from Karachi highlighted the role of hypertension and diabetes in increasing STEMI-related mortality.[7] Another study found a significant association between Killip classification and mortality rates in STEMI patients undergoing PCI in Pakistan.[10] These studies reinforce the importance of risk stratification in STEMI patients but have not specifically addressed anaemia's role, making this study an important contribution to the existing literature.

Anaemia contributes to myocardial ischemia by impairing oxygen delivery, worsening ischemic injury, and increasing cardiovascular stress. The European Society of Cardiology (ESC) and American College of Cardiology (ACC) guidelines acknowledge anaemia as a risk factor for adverse cardiovascular outcomes but provide limited region-specific recommendations for South Asia [(ESC Guidelines, 2023)]. Moreover, conflicting data exist regarding whether blood transfusions benefit anaemic STEMI patients, with some studies suggesting potential harm due to increased viscosity and thrombosis risk.[5] Given these debates, further research tailored to the Pakistani population is warranted.

This study provides compelling evidence that low haemoglobin significantly increases in-hospital mortality in STEMI patients undergoing PCI. The observed association between anaemia and adverse outcomes suggests a potential need for early screening and management of haemoglobin levels in high-risk patients. Moreover, given that diabetes and hypertension were also significant predictors of mortality, a multidisciplinary approach may be beneficial in reducing risk.

Study Limitations and Future Directions

Despite its valuable contributions, this study has some limitations. First, its retrospective nature limits causal inference. Second, the study was conducted at a single centre, potentially limiting generalizability. Third, factors such as nutritional deficiencies contributing to anaemia were not assessed. Future prospective studies

incorporating larger multi-centre cohorts and evaluating interventions to optimize haemoglobin levels before PCI are needed. Additionally, research on the role of blood transfusions in anaemic STEMI patients in Pakistan could provide valuable clinical insights.

CONCLUSION

This study highlights the significant impact of low haemoglobin levels on in-hospital mortality among patients with STEMI undergoing primary PCI. The findings align with the study objective, demonstrating that patients with lower haemoglobin levels had a markedly higher risk of adverse outcomes, including mortality. Additionally, comorbidities such as diabetes and hypertension further compounded the risk, emphasizing the need for comprehensive patient evaluation.

The study results strongly support the drawn conclusions, reinforcing existing literature that anaemia is an independent predictor of poor cardiovascular outcomes. These findings underscore the importance of early identification and management of anaemia in STEMI patients to improve survival rates.

Future Recommendations

Further prospective, multi-center studies are needed to establish causality and evaluate the role of targeted interventions in optimizing haemoglobin levels before and after PCI. Additionally, research on the effectiveness of blood transfusion strategies and alternative therapies for anaemic STEMI patients in Pakistan should be prioritized to improve patient outcomes.

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