Prognostic value of admission hemoglobin levels in ST-segment elevation myocardial infarction patients presenting with cardiogenic shock.

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ABSTRACT

BACKGROUND
Even in the era of primary percutaneous coronary intervention (PCI) in patients with ST-segment elevation myocardial infarction (STEMI) complicated by cardiogenic shock (CS), mortality remains high. Whether admission hemoglobin (Hb) concentration is a predictor of mortality in patients with CS treated with primary PCI is unexplored. We assessed the relation between admission Hb concentration and 1-year mortality in patients with STEMI and CS who were treated with PCI at admission.

METHODS AND RESULTS
We investigated a cohort of 265 patients with STEMI with CS on admission. Patients were categorized in 3 groups according to plasma Hb levels at admission: < 9.6 g/dl (group I, n = 22), 9.6 to 12 g/dl (group II, n = 59), and >12 g/dl (group III, n = 184). All-cause mortality at 1 year was 64%, 46%, and 35% for groups I, II, and III, respectively (p = 0.007). Multivariate logistic regression analysis showed that the odds for mortality increased 17% for every 1.0 g/dl decrease in plasma Hb (odds ratio 1.17, 95% confidence interval 1.01 to 1.35, p = 0.042).

CONCLUSION
Admission Hb concentration is an independent predictor for 1-year mortality in patients with STEMI undergoing primary PCI.
INTRODUCTION

Anemia is associated with poor clinical outcome in patients with acute coronary syndromes, patients with end-stage heart failure, and elderly patients with acute myocardial infarction. Even in the era of primary percutaneous intervention (PCI) as therapy of choice in patients with ST-segment elevation myocardial infarction (STEMI), short-term survival is 2 times lower for patients with anemia. Whether admission hemoglobin (Hb) level is an independent predictor of long-term mortality in patients with cardiogenic shock presenting with STEMI is unclear. We therefore investigated the relation between admission Hb level and 1-year mortality after PCI in patients with STEMI presenting with cardiogenic shock.

METHODS AND RESULTS

A group of 3,038 patients was treated for STEMI with PCI from October 1997 to March 2005 and was registered in our dedicated database. In total, 292 patients had STEMI complicated by cardiogenic shock on admission. Cardiogenic shock was defined according to the Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock (SHOCK) trial. Admission Hb data were missing from 27 patients. Therefore, the present analysis includes 265 patients. Follow-up information was obtained 1 year after the initial event by written questionnaire sent to all patients. If necessary, outpatients’ reports were reviewed, general practitioners were contacted by telephone, or we consulted the municipal registry for all deaths. Follow-up was completed in all patients.

Patients were categorized into 3 groups according to plasma Hb levels at admission: <9.6 g/dl (n = 22, group I), ≥9.6 to <12.0 g/dl (n = 59, group II), and ≥12.0 g/dl (n = 184, group III). These cut-off levels were chosen according to the World Health Organization definition for anemia in combination with guidelines for red blood cell transfusion.

Differences in clinical and angiographic baseline characteristics across the 3 groups were tested by chi-square test. Multivariate logistic regression analysis was performed to assess the independent value of admission Hb concentration on mortality after 1-year follow-up. The multivariate model included all variables that were significantly associated in univariate analysis, such as residual left ventricular ejection fraction (LVEF, <40%) and Thrombolysis In Myocardial Infarction (TIMI) grade 3.
flow after PCI. All tests were 2-tailed, and a p value <0.05 was considered statistically significant. Twenty-two patients (8.3%) had a Hb level <9.6 g/dl (group I), 59 patients (22.3%) had a Hb level from 9.6 to 12 g/dl (group II), and 184 patients (69.4%) had a normal Hb level (group III) on admission. After 1-year follow-up, 106 patients (40%) in the study cohort died, and 98 (93%) of these died within the first 30 days. One-year mortalities were 64% in group I, 46% in group II, and 35% in group III (p for trend = 0.007; FIGURE 1). Except for age >60 years and gender, there were no significant differences across the 3 groups in body mass index, risk factors, previous myocardial infarction, previous coronary angioplasty or coronary artery bypass grafting, angiographic characteristics (infarct-related artery, multivessel disease, TIMI grade 3 flow before and after PCI), and LVEF <40%. Patients >60 years of age constituted 77%, 78%, and 54% of groups I, II, and III, respectively (p <0.001) and 46%, 41%, and 28% of patients in groups I, II, and III, respectively, were women (p <0.08 and <0.03, respectively, for trend). Multivariate logistic regression analysis showed that the odds for mortality increased by 17% for every 1.0-g/dl decrease in plasma Hb concentration (odds ratio [OR] 1.17, 95% confidence interval [CI] 1.01 to 1.35, p = 0.042) even after adjustment for LVEF <40% (OR 19.23, 95% CI 4.44 to 83.33, p <0.001), age >60 years (OR 2.17, 95% CI 1.07 to 4.41, p = 0.031), and TIMI grade 3 flow after PCI (OR 0.46, 95% CI 0.23 to 0.91, p = 0.026; TABLE 1). Alternatively, for every 1-mmol/L decrease in Hb concentration, morta-
TABLE 1  Independent predictors of 1 year mortality

<table>
<thead>
<tr>
<th></th>
<th>OR*</th>
<th>(95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb (g/dL)</td>
<td>1.17</td>
<td>1.01 - 1.35</td>
<td>0.042</td>
</tr>
<tr>
<td>LVEF &lt; 40%</td>
<td>19.23</td>
<td>4.44 - 83.33</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Age &gt; 60 years</td>
<td>2.17</td>
<td>1.07 - 4.41</td>
<td>0.031</td>
</tr>
<tr>
<td>Women</td>
<td>0.91</td>
<td>0.45 - 1.84</td>
<td>0.795</td>
</tr>
<tr>
<td>TIMI grade 3 flow after PCI</td>
<td>0.46</td>
<td>0.23 - 0.91</td>
<td>0.026</td>
</tr>
</tbody>
</table>

* For the continuous variable, admission Hb concentration (grams per deciliter), the OR is noted per unit of increment. The Nagelkerke $R^2$ value, a measurement of predictive capability, for the model is 29%; $1 - R^2$ is the proportion of predictive capability attributable to causal factors not contained in the model, to a different model form and/ or to random effects. Hb=hemoglobin; LVEF=residual left ventricular ejection fraction; TIMI=thrombolysis in myocardial infarction.

Mortality increased by 28% (OR 1.28, 95% CI 1.01 to 1.62, p= 0.0042) in the same multivariate model.

**DISCUSSION**

This study shows that a decreased Hb concentration on admission is an independent predictor for 1-year mortality in patients with cardiogenic shock presenting with STEMI. The prevalence of anemia according to the World Health Organization (Hb level < 12 g/dl) in a general population with STEMI is ~15%\(^8\).

In our study, the incidence of cardiogenic shock in patients with anemia (groups I and II) was 30%. One potential mechanism may be decreased oxygen delivery to the ischemic myocardium in an anemic patient. Moreover, patients in cardiogenic shock have increased wedge pressure and thus hampered oxygen and carbon dioxide exchange at the pulmonary level,\(^9\) resulting in even lower oxygenation of the already decreased Hb level on admission. Further, in cardiogenic shock, the coronary circulation is likely to be decreased due to low blood pressure and low cardiac output and therefore low coronary flow in the anemic patient.

Whether anemia is causally related to an excess risk of death remains unclear. All accompanying compensatory mechanisms, such as increased sympathetic activity...
and peripheral vasoconstriction, will lead to increased heart rate and afterload. All these factors result in increased cardiac demand, and therefore, oxygen supply and, hence, a vicious circle and worse clinical outcome.

Our study is a single-center registry. However, this is the largest single-center cohort of patients with STEMI and shock treated with PCI over many years (from 1997 to 2005). Selection bias could have played a role in our study because our overall mortality (40%) was somewhat lower than that in other studies.\textsuperscript{10} Further study is needed to determine whether a low Hb level is a modifiable factor in patients presenting with acute myocardial infarction and cardiogenic shock.
REFERENCES


2 Newton JD, Squire IB. Glucose and haemoglobin in the assessment of prognosis after first hospitalisation for heart failure. Heart 2006 October;92(10):1441-1446


