In Patients With Acute Myocardial Infarction, the Impact of Hyperglycemia as a Risk Factor for Mortality Is Not Homogeneous Across Age-Groups

Jose Carlos Nicolau, MD, PhD
Carlos Vicente Serrano Jr., MD, PhD
Roberto Rocha Giraldes, MD
Luciano Moreira Baraccoli, MD
Humberto Graner Moreira, MD
Felipe Lima, MD

Marcelo Franken, MD
Roberto Kalil, MD, PhD
Jose Antonio Franchini Ramires, MD, PhD
Robert P. Giugliano, MD, SM

OBJECTIVE—To assess the impact of hyperglycemia in different age-groups of patients with acute myocardial infarction (AMI).

RESEARCH DESIGN AND METHODS—A total of 2,027 patients with AMI were categorized into one of five age-groups: <50 years (n = 301), ≥50 and <60 (n = 477), ≥60 and <70 (n = 545), ≥70 and <80 (n = 495), and ≥80 years (n = 209). Hyperglycemia was defined as initial glucose ≥115 mg/dL.

RESULTS—The adjusted odds ratios for hyperglycemia predicting hospital mortality in groups 1–5 were, respectively, 7.57 (P = 0.004), 3.21 (P = 0.046), 3.50 (P = 0.003), 3.20 (P < 0.001), and 2.16 (P = 0.021). The adjusted P values for correlation between glucose level (as a continuous variable) and mortality were 0.007, <0.001, 0.043, <0.001, and 0.064. The areas under the ROC curves (AUCs) were 0.785, 0.709, 0.657, 0.648, and 0.613. The AUC in group 1 was significantly higher than those in groups 3–5.

CONCLUSIONS—The impact of hyperglycemia as a risk factor for hospital mortality in AMI is more pronounced in younger patients.

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Statistical analyses

Categorical variables are described as numbers and percentages and continuous variables as median (25th, 75th percentiles) or mean ± SD.

For the correlation between hyperglycemia and hospital mortality, the χ² test was used, with the Mann-Whitney U test used for the correlation between GL (as continuous variable) and mortality. The mean GL among the groups was compared with ANOVA. Stepwise logistic regression method was applied for the comparison between hyperglycemia as a categorical variable or GL (continuous variable) with mortality (dependent variable). Two different models were developed. The first model included age, hyperglycemia (or GL), sex, ST-elevation AMI, and a history of angina, dyslipidemia, relatives with coronary artery disease, smoking, hypertension, heart failure, diabetes, stroke, coronary artery bypass surgery, percutaneous coronary intervention (PCI), and myocardial infarction. The second model included the previous variables plus primary PCI, nonprimary PCI, coronary artery bypass surgery, and fibrinolytic use during the in-hospital phase. Because there was no significant correlation between LDL or HDL and mortality, and the P interactions for these variables and hyperglycemia or GL regarding mortality were nonsignificant, neither LDL nor HDL was included in the models.

To analyze the accuracy of GLs in predicting in-hospital deaths, receiver operating characteristic (ROC) curves were constructed for each group and compared with the DeLong method. P values <0.05 were considered significant; MedCalc version 11.4.4 statistical software (MedCalc Software, Mariakerke, Belgium) was used for these analyses.

From the 1Heart Institute (InCor), University of São Paulo Medical School, São Paulo, Brazil; and the 2Thrombolysis in Myocardial Infarction (TIMI) Study Group, Brigham and Women’s Hospital, Boston, Massachusetts.

Corresponding author: Jose Carlos Nicolau, corjnicolau@incor.usp.br.

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RESULTS—The mean GLs (in mg/dL) for groups 1–5 were, respectively, 125.8 ± 62.7, 139.5 ± 69.4, 143.9 ± 69.8, 143.7 ± 69.8, and 136.7 ± 72.1. In comparison with group 1, the P values for groups 2–5 were, respectively, 0.052, 0.002, 0.003, and 0.398.

GLs were significantly higher among patients who died in hospital compared with survivors in all age-groups. Moreover, the mean difference in GL between deceased and survivors was larger in the youngest population when compared with the eldest population (65.6 ± 16.2 vs. 22.9 ± 11.1 mg/dL, P < 0.001). The adjusted t ratios (P values) for groups 1–5 in the first model (only baseline variables) were, respectively, 2.96 (P = 0.003), 4.47 (P < 0.001), 2.04 (P = 0.042), 3.48 (P < 0.001), and 1.85 (P = 0.064); for the second model (baseline variables + in-hospital interventions), the respective figures were 2.71 (P = 0.007), 4.47 (P = 0.007), 2.04 (P = 0.042), 3.48 (P < 0.001), and 1.85 (P = 0.064).

By univariate analyses, the odds ratios (P values) for in-hospital mortality in patients with hyperglycemia were the following for groups 1–5: 7.22 (P = 0.001), 3.17 (P = 0.038), 3.15 (P = 0.003), 3.31 (P < 0.001), and 2.07 (P = 0.021), respectively. In the first adjusted model (baseline variables), the respective group figures were 6.93 (P = 0.004), 3.21 (P = 0.046), 3.42 (P = 0.004), 3.20 (P < 0.001), and 2.29 (P = 0.013). In the second adjusted model (baseline + in-hospital variables), the figures were 7.57 (P = 0.004), 3.21 (P = 0.046), 3.50 (P = 0.003), 3.20 (P < 0.001), and 2.16 (P = 0.021), respectively.

The results of the area under the ROC curves (AUCs) are depicted in Table 1, with best results obtained for the youngest population (AUC = 0.785) and the lowest AUC in the eldest population (AUC = 0.613).

DISCUSSION—The main finding of our study is the observation that hyperglycemia in patients with AMI is a better predictor for mortality in younger patients than in the elderly population. The increased mortality related to hyperglycemia in AMI patients has been linked to different pathophysiologic mechanisms (6–8), such as increased oxidative stress, inflammation, and activation of stress-responsive kinases. Moreover, hyperglycemia is strongly correlated with impaired coronary flow before reperfusion and has been associated with enhanced thrombin formation, platelet activation, and fibrin clot resistance to lysis. In addition, hyperglycemia has been linked to increased sensitivity to ischemia-reperfusion injury (9,10). Since the individual response to these processes (among others) varies with age, this could explain, at least in part, our results.

Another explanation for our findings (not exclusive of the previous) relates to the importance of age itself as a risk factor for mortality. Since advanced age is a strong independent risk factor for mortality in patients with AMI, hyperglycemia may have a relatively greater importance in younger populations and a weaker impact in the elderly population.

Clinical implications
There have been conflicting results regarding the clinical benefit of intensive glucose control in AMI patients (11–13). Several possible explanations for the lack of consistent benefit with intensive glucose management have been proposed, but the leading hypothesis is that it leads to a higher incidence of hypoglycemia, which is quite deleterious in AMI patients (14). Our results add another nuance to this debate: intensive glucose control may have different effects depending on the age of the patient.

CONCLUSIONS—The value of hyperglycemia as a risk factor for in-hospital mortality in patients with AMI is not homogeneous, with a greater relative impact on mortality in the younger population. This finding may have clinical implications regarding the therapeutic approach to hyperglycemia in patients with AMI (15).

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Table 1—ROC curves according to analyzed age-groups

| Age-group (years) | AUC | 95% CI          | P value |
|-------------------|-----|-----------------|---------|
| Global            | 0.655 | 0.617–0.693    | <0.001  |
| <50*              | 0.785 | 0.697–0.873    | <0.001  |
| ≥50 and <60       | 0.709 | 0.551–0.867    | 0.004   |
| ≥60 and <70       | 0.657 | 0.576–0.738    | 0.002   |
| ≥70 and <80       | 0.648 | 0.583–0.710    | <0.001  |
| ≥80               | 0.613 | 0.523–0.701    | 0.012   |

The AUC revealed a close relationship between age and predictive value of GLs for in-hospital mortality. The AUC for the global population was 0.655, and once again the best result was obtained for the youngest population (AUC = 0.785); in a descending way among the groups, the least predictive result was obtained for the oldest population. *P = 0.035 vs. aged 60–69, P = 0.013 vs. aged 70–79, P = 0.007 vs. aged >80; other comparisons statistically nonsignificant.

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