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# PREDICTORS OF PROGNOSIS IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

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## ABSTRACT
The determinants of prognosis in patients with acute myocardial infarction at a tertiary care hospital were studied. Demographic and risk variables were explored in the outcome (survived or died) of AMI patients during hospital treatment. Bivariate analysis was performed and unadjusted odds ratios were calculated for each of the variables. Binary logistic regression analysis (forward Wald method) was carried out to obtain adjusted or standardized odds ratios. For group comparisons Pearson $\chi^2$ test, $\chi^2$ for trend and student's t-test were used. Mortality was 21.2% during treatment among the AMI inpatients. Mortality was higher among females compared to males (28% v/s 19.4%). On binary logistic regression analysis, time elapsed before reporting for treatment, length of hospital stay and systolic blood pressure at admission were found to be the significant variables determining outcome. The sensitivity and specificity of the model were 62.7% and 97.9% respectively at cut-off probability of death ≥ 0.5. The overall predictive ability of the model was 91.1%. Patient outcomes in acute myocardial infarction could be improved by consistent use of these predictors as they would alert the physician about potential bad outcomes resulting in institution of timely interventions in identified at risk patients. This analysis provides an evidence base which the treating physician can use while taking decisions on the mode of treatment.

**KEY WORDS:** Acute Myocardial Infarction, prognosis, predictors.

## INTRODUCTION
Acute Myocardial Infarction (AMI) is a serious complication of atherosclerotic coronary heart disease. Overall mortality of AMI is 15-30%, possibly varying with treatment (Davies, 2002). Despite impressive strides in diagnosis and management over the past three decades, Acute Myocardial Infarction continues to be a major public health problem in the industrialized world and is becoming an increasingly important problem in developing countries (Chockalingam, 1999). At present all AMI patients presenting at a health facility in India are treated according to standard treatment protocol. There is however no evidence based system to prioritize patients. The present study provides an evidence base which the treating physician can use while taking decisions regarding treatment. Patient outcomes in acute myocardial infarction could be improved by consistent use of the predictors identified in the study. These predictors would alert the physician about potential bad outcomes and thereby help in institution of timely and appropriate interventions in identified "more likely to die" patients.

## MATERIALS AND METHODS
Case histories of Acute Myocardial Infarction (AMI) in-patients treated at a tertiary care hospital in Goa in the preceding one year (2011) were retrospectively analyzed. Demographic and risk variables were explored to study their role in the outcome of AMI patients during hospital treatment. The outcome variable was hospital discharge status (Survived or Died). The demographic variables were: age, sex, place of residence, time of onset of disease, time elapsed before seeking treatment and hospital stay. The risk variables studied were: presence of Ischemic Heart Disease (IHD), Diabetes Mellitus, hypertension, smoking, alcohol use, and history of past MI. In addition clinical and laboratory parameters were also analyzed i.e. blood pressure at admission to hospital, fasting blood sugar, blood lipids etc. Bivariate analysis was performed and unadjusted odds ratios were calculated for each of the variables. Binary logistic regression analysis (forward Wald method) was carried out to obtain adjusted or standardized odds ratios. The reference categories for regression analysis were selected based on the unadjusted odds ratios obtained on bivariate analysis. The model with the best set of predictor variables was selected based on coefficient of determination ($R^2$) and log likelihood. The final suggested model was obtained at 3rd step. For group comparisons Pearson $\chi^2$ test, $\chi^2$ for trend and student's t-test were used. Cornfields 95% confidence intervals for odds ratios were calculated in bivariate analysis. Ethics committee of the institute approved the study.

## RESULTS
Records of 321 consecutive patients with Acute Myocardial Infarction (AMI) admitted at the hospital during the year 2011 were analyzed. There were 68 deaths (21.2%) during treatment among the AMI inpatients. Mortality was higher among females compared to males (28% v/s 19.4%; p=0.10).

**TABLE 1:** Demographic determinants of prognosis in Acute Myocardial Infarction in-patients

| Variable | No. n=321 | Died No. (%) n=68 | Survived No. (%) n=253 | OR *(95% CI)* | *p-value* |
|---|---|---|---|---|---|
| Age (yrs) | | | | | |
| < 50 yrs | 63 | 8 (12.7%) | 55 (87.3%) | 1 *(Ref)* | *p = 0.000* |
| 50-70 yrs | 192 | 34 (17.7%) | 158 (82.3%) | 1.48 *(0.61-3.70)* | |
| 70+ yrs | 66 | 26 (39.4%) | 40 (60.6%) | 4.47 *(1.70-12.05)* | |
| Gender | | | | | |
| Male | 258 | 30 (19.4%) | 208 (80.6%) | 1 *(Ref)* | *p = 0.109* |
| Female | 63 | 18 (28.6%) | 45 (71.4%) | 1.66 *(0.85-3.25)* | |
| Residence | | | | | |
| Urban | 91 | 19 (20.9%) | 72 (79.1%) | 1 *(Ref)* | *p = 0.933* |
| Rural | 230 | 49 (21.3%) | 181 (78.7%) | 1.03 *(0.54-1.95)* | |
| Onset time *(24 hr format)* | | | | | |
| 00.00-08.00 hrs | 37 | 4 (10.8%) | 33 (89.2%) | 1 *(Ref)* | *p = 0.441* |
| 08.00-16.00 hrs | 110 | 14 (12.7%) | 96 (87.3%) | 1.20 *(0.34-4.68)* | |
| 16.00-24.00 hrs | 76 | 14 (18.4%) | 62 (81.6%) | 1.86 *(0.51-7.34)* | |
| NA | 98 | 36 (36.7%) | 62 (63.3%) | | |
| Elapsed time | | | | | |
| 0-6 hrs | 146 | 22 (15.1%) | 124 (84.9%) | 1 *(Ref)* | *p = 0.002* |
| 6-12 hrs | 44 | 10 (22.7%) | 34 (77.3%) | 1.66 *(0.66-4.12)* | |
| 12-24 hrs | 18 | 0 (0%) | 18 (100%) | 0 *(0-1.70)* | |
| 24+ hrs | 87 | 28 (32.2%) | 59 (67.8%) | 2.67 *(1.35-5.32)* | |
| NA | 26 | 8 (30.8%) | 18 (69.2% | | |
| Hospital stay | | | | | |
| <48 hrs | 47 | 40 (85.1%) | 7 (14.9%) | 63.67 *(23.6-179.2)* | *p = 0.000* |
| 48-96 hrs | 19 | 7 (36.8%) | 12 (63.2%) | 6.50 *(2.05-20.33)* | |
| 96+ hrs | 255 | 21 (8.2%) | 234 (91.8%) | 1 *(Ref)* | |

*NA: Data not available

**TABLE 2:** Risk variables for prognosis in Acute Myocardial Infarction in-patients

| Variable | No. N=321 | Died No (%) n=68 | Survived No. (%) n=253 | OR *(95% CI)* | *p-value* |
|---|---|---|---|---|---|
| IHD | | | | | |
| Present | 87 | 24 (27.6%) | 63 (72.4%) | 1.68 *(0.91-3.11)* | *p = 0.074* |
| Absent | 233 | 43 (18.5%) | 190 (81.5%) | 1 *(Ref)* | |
| NA | 1 | 1 (100%) | 0 (0%) | | |
| Diabetes | | | | | |
| Present | 107 | 28 (26.2%) | 79 (73.8%) | 1.58 *(0.88-2.85)* | *p = 0.103* |
| Absent | 213 | 39 (18.3%) | 174 (81.7%) | 1 *(Ref)* | |
| NA | 1 | 1 (100%) | 0 (0%) | | |
| Hypertension | | | | | |
| Present | 176 | 33 (18.8%) | 143 (81.3%) | 0.73 *(0.40-1.38)* | *p = 0.240* |
| Absent | 145 | 35 (24.1%) | 110 (75.9%) | 1 *(Ref)* | |
| Smoking | | | | | |
| Present | 112 | 20 (17.9%) | 92 (82.1%) | 0.74 *(0.40-1.38)* | *p = 0.320* |
| Absent | 208 | 47 (22.6%) | 161 (77.4%) | 1 *(Ref)* | |
| NA | 1 | 1 (100%) | 0 (0%) | | |
| Alcohol use | | | | | |
| Present | 55 | 7 (12.7%) | 48 (87.3%) | 0.49 *(0.19-1.20)* | *p = 0.092* |
| Absent | 266 | 61 (22.9%) | 205 (77.1%) | 1 *(Ref)* | |
| Past AMI | | | | | |
| Present | 32 | 9 (28.1%) | 23 (71.9%) | 1.53 *(0.62-3.69)* | *p = 0.311* |
| Absent | 289 | 59 (20.4%) | 230 (79.6%) | 1 *(Ref)* | |
| Systolic BP | | | | | |
| ≥ 140 mmHg | 126 | 11 (8.7%) | 115 (91.3%) | 1 *(Ref)* | *p = 0.000* |
| <140 mmHg | 193 | 56 (29.0%) | 137 (71.0%) | 4.27 *(2.05-9.09)* | |
| NA | 2 | 1 (50%) | 1 (50%) | | |
| Diastolic BP | | | | | |
| ≥ 90 mmHg | 114 | 13 (11.4%) | 101 (88.6%) | 1 *(Ref)* | |
| <90 mmHg | 205 | 54 (26.3%) | 151 (73.7%) | 2.78 *(1.39-5.66)* | *p = 0.002* |
| NA | 2 | 1 (50%) | 1 (50%) | | |
| FBSL | | | | | |
| ≥ 126 mg/dl | 89 | 17 (19.1%) | 72 (80.9%) | 2.64 *(1.10-6.42)* | *p = 0.016* |
| <126 mg/dl | 134 | 11 (8.2%) | 123 (91.8%) | 1 *(Ref)* | |
| NA | 98 | 40 (40.8%) | 58 (59.2%) | | |

*NA: Data not available

Table 1 shows the role of demographic variables in prognosis of AMI inpatients. Age (p=0.000), length of hospital stay (p=0.000), time elapsed before initiation of treatment (p=0.002) and time of the year (p=0.000) were found to be significant variables affecting survival in the AMI inpatients. Patients aged above 70 years were more likely to die during treatment than those below 50 years (OR=4.47). Mortality was also higher in: those reporting late (> 24 hrs) to the hospital (OR=2.67) and those having shorter (<48 hrs) length of hospital stay (OR=63.67)as shown in table-1.

Mortality from AMI was found to increase with increase in age of patient ($\chi^2$ for trend =13.95, p=0.000), increasing delay in initiating treatment ($\chi^2$ for trend =7.4, p=0.007) and decrease in length of hospital stay ($\chi^2$ for trend =141.99, p=0.000).

Table 2 shows bivariate analysis of risk variables and outcome among AMI inpatients. Low systolic and low diastolic blood pressure at admission significantly increased mortality due to AMI (p=0.000 and p=0.002 respectively). High fasting blood sugar level on admission (≥126mg/dl) also led to higher mortality (OR=2.64). Presence of Ischemic Heart Disease, Diabetes Mellitus and Hypertension had no effect on the outcome. Incidentally mortality was found to be lower among smokers and alcohol users however, these findings were not statistically significant.

**TABLE 3:** Binary Logistic regression analysis of determinants of prognosis of AMI

| Variable | ß | SE (ß) | p value | OR (95% CI) |
|---|---|---|---|---|
| Elapsed time | | | | |
| 0-6 hrs | ---- | ---- | ---- | 1 *(Ref)* |
| 6-12 hrs | 0.862 | 0.627 | 0.17 | 2.37 *(0.69-8.09)* |
| 12-24 hrs | -18.158 | 0.921 | 0.998 | 0.00** |
| 24+ hrs | 1.451 | 0.491 | 0.003 | 4.27 *(1.63-11.17)* |
| Hospital stay | | | | |
| <48 hrs | 4.682 | 0.631 | 0.000 | 107.96 *(31.37-371.60)* |
| 48-96 hrs | 2.456 | 0.684 | 0.000 | 11.66 *(3.05-44.52)* |
| 96+ hrs | ---- | ---- | ---- | 1 (Ref) |
| Systolic BP | | | | |
| ≥ 140 mmHg | ---- | ---- | ---- | 1*( Ref)* |
| <140 mmHg | 1.685 | 0.528 | 0.001 | 5.39 *(1.92-15-17)* |
| Constant | -4.358 | 0.622 | 0.000 | ---- |

** No deaths in this category hence results inconsistent

**TABLE 4:** Summary of some selected variables among survivors and non-survivors

| Variable | Survived Mean ± *SD* | Died Mean ± *SD* | *p value* |
|---|---|---|---|
| Age (Yrs) | 57.30 ± *11.07* | 63.72 ± *12.79* | *0.000* |
| Elapsed time (Hrs) | 14.95 ± *19.85* | 24.63 ± *26.16* | *0.009* |
| Hospital stay (Days) | 8.08 ± *4.03* | 3.70 ± *5.40* | *0.000* |
| FBSL (mg/dl) | 134.02 ± *65.86* | 190.92 ± *132.39* | *0.033* |
| Cholesterol (mg/dl) | 193.04 ± *42.71* | 180.62 ± *56.17* | *0.262* |
| Triglyceride (mg/dl) | 119.31 ± *50.87* | 111.85 ± *69.71* | *0.494* |
| Systolic BP (mm Hg) | 137.37 ± *27.71* | 106.17 ±*3 2.72* | *0.000* |
| Diastolic BP (mm Hg) | 82.74 ± *19.65* | 54.04 ± *39.72* | *0.000* |

Results of the binary logistic regression model are shown in table 3. Time elapsed before reporting for treatment, length of hospital stay and systolic blood pressure at admission were the significant variables found in the analysis. The sensitivity and specificity of the model were 62.7% and 97.9% respectively at cut-off probability of death ≥ 0.5. Coefficient of determination ($R^2$) was 0.60. The overall predictive ability of the model was 91.1%.

Table 4 gives the mean and SD of selected variables for the two outcomes (Survived or died). In patients, who experienced mortality were: older (63.72 v/s 57.30 yrs), reported late for treatment (24.63 v/s 14.95 hrs), had a shorter hospital stay (3.70 v/s 8.08 days), had higher fasting blood sugar levels (190.92 v/s 134.02 mg/dl) and low blood pressure measurement at admission (Systolic: 106.17 v/s 137.37 mm Hg; Diastolic: 54.04 v/s 82.74 mm Hg)

## DISCUSSION

Overall mortality was 21.2% among AMI inpatients in the study. Kakade *et al.* (2006) reported mortality rate of 33.2% in their study in Maharashtra. Mortality of 20.2% was reported by Ivanusa *et al.* (2007) in their study in Croatia.

On bivariate analysis age, length of hospital stay, time elapsed before initiation of treatment and time of the year were found to be significant demographic variables affecting outcome in the AMI inpatients in our study. Kakade *et al.* (2006) reported age, gender and length of hospital stay as significant variables affecting outcome in AMI inpatients. Time elapsed for treatment was not associated with survival in their study.

Females had higher mortality compared to males this however, was not statistically significant. Kakade *et al.* (2006) reported that being female significantly increased mortality due to AMI (p<0.05). He, j. et al. (1994) found that women had significantly higher short term mortality compared to men in Beijing (p<0.001). Hanratty *et al.* (2000) and Jiang *et al.* (2006) also reported higher mortality among female AMI patients (p<0.001 and p=0.00 respectively).

Low systolic and low diastolic blood pressure at admission as well as High fasting blood sugar level on admission significantly increased mortality due to AMI. Presence of Ischemic Heart Disease, Diabetes Mellitus and Hypertension had no association with outcome. Mortality was found to be lower among smokers and alcohol users.

Kakade *et al.* (2006) found that presence of diabetes and hypertension significantly increased mortality from AMI. They also reported lower mortality among alcohol users and smokers. Ivanusa *et al*. (2007) reported that survivors had higher prevalence of hypertension and smoking. Yap *et al.* (2005) reported that low baseline systolic blood pressure, male gender and presence of diabetes as significant predictors of mortality in AMI patients.

Binary logistic regression analysis identified only three predictor variables for prognosis of AMI inpatients. Patients reporting early to the hospital, having longer stay and those with higher systolic blood pressure at admission were likely to have better prognosis during admission. Length of hospital stay operates differently than other predictors i.e. if a patient survives the first 48 hours than his risk of dying from AMI decreases significantly with increasing length of stay.

Kakade *et al.* (2006) found that on logistic regression analysis; age, gender, place of residence, time gap in treatment, and hospital treatment were the significant variables. Jiang *et al.* (2006) using a multivariate logistic regression model identified age, history of hypertension, and diabetes mellitus as significant predictors of in-hospital mortality in patients with AMI.

## CONCLUSION & RECOMMENDATIONS

Time gap in reporting to the hospital for treatment, length of hospital stay and systolic blood pressure measurement at admission were identified as the important predictors of in-hospital mortality among patients admitted with acute myocardial infarction. Clinicians would find these prognostic predictors useful to classify and prioritize their patients. This analysis provides an evidence base which the treating physician can use while taking decisions on the mode of treatment. Patient outcomes in acute myocardial infarction could be improved by consistent use of these predictors as they would alert the physician about potential bad outcomes resulting in institution of timely interventions in identified at risk patients.

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