

# Prognostic impact of blood pressure and heart rate at admission on in-hospital mortality after primary percutaneous intervention for acute myocardial infarction with ST-segment elevation in western Romania

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**Background:** The purpose of this retrospective study was to evaluate the prognostic impact of systolic blood pressure (SBP) and heart rate (HR) on in-hospital mortality in ST-segment elevation acute myocardial infarction (STEMI) patients, after primary percutaneous intervention (PCI).

**Patients and methods:** The study included 294 patients admitted for STEMI. They were divided into five groups according to the SBP at admission: group I, <105 mmHg; group II, 105–125 mmHg; group III, 126–140 mmHg; group IV, 141–158 mmHg; and group V,  $\geq 159$  mmHg. Increased HR was defined as  $\geq 80$  beats per minute (bpm). In-hospital death was defined as all-cause death during admission and classified into cardiac and noncardiac death.

**Results:** Among the 294 patients admitted for STEMI, 218 (74%) were men. The mean age was  $62 \pm 17$  years. In-hospital mortality rate was 6% (n=18), with 11 (3.7%) deaths having cardiac causes. The highest mortality was registered in group I (n=9, 16%,  $P=0.018$ ). Compared to the other groups, group I patients were older ( $P=0.033$ ), more often smokers ( $P=0.026$ ), and had a history of myocardial infarction ( $P=0.003$ ), systemic hypertension ( $P=0.023$ ), diabetes ( $P=0.041$ ), or chronic kidney disease ( $P=0.0200$ ). They more often had a HR  $\geq 80$  bpm ( $P=0.028$ ) and a Killip class 3 or 4 at admission ( $P=0.020$ ). The peak creatine phosphokinase-MB level was significantly higher in this group ( $P=0.005$ ), while the angiographic findings more often identified as culprit lesions were the right coronary artery ( $P=0.005$ ), the left main trunk ( $P=0.040$ ), or a multivessel coronary artery disease ( $P=0.044$ ). Multivariate analysis showed that group I patients had a significantly higher risk for both all-cause death ( $P=0.006$ ) and cardiac death ( $P=0.003$ ). Patients with HR  $\geq 80$  bpm also had higher mortality rates ( $P=0.0272$  for general mortality and  $P=0.0280$  for cardiac mortality).

**Conclusion:** The present study suggests that SBP <105 mmHg and HR  $\geq 80$  bpm at admission of STEMI patients are associated with a higher risk of in-hospital death, even after primary PCI.

**Keywords:** blood pressure, heart rate, STEMI, primary PCI, outcome

## Introduction

In Romania, cardiovascular diseases account for 63% of all deaths, while in Europe the percentage is 37%.<sup>1</sup> Acute myocardial infarction (AMI) is by far the leading cause of death

in patients with ischemic heart disease. In our country, ~13,000 people annually suffer from AMI, with mortality rates reaching worrying levels. The risk of death is maximum within the first 2 hours of onset of the disease. According to the data from some studies, 52% of deaths occur before the patient reaches the hospital. The mortality rate drops dramatically after admission: 19% in the first 24 hours and only 8% on the second day. Finally, 21% of deaths occur later, up to 30 days.<sup>1</sup>

Studies published over the past 20 years have undoubtedly demonstrated that early coronary reperfusion significantly reduces mortality, reduces the infarct area, and leads to a better preservation of contractile heart function.<sup>6</sup> Furthermore, reperfusion significantly reduces the risk of ventricular fibrillation. A prompt intervention in these patients, according to existing resuscitation protocols (basic support and advanced support of life), triple their survival chances and can reduce the risk of developing post-resuscitation neurological sequel by more than 50%.<sup>2</sup>

Over the past decade, in-patient treatment of patients with myocardial infarction has improved substantially as a result of the efforts made by the Romanian Society of Cardiology to implement progress in the field, in line with international guidelines. For prehospital quantification of the prognostic risk of patients with AMI, the parameters that can be quantified during the first medical consultation are very useful and are routinely included in the medical examination: heart rate (HR) and blood pressure (BP).

The Global Registry of Acute Coronary (GRACE) score is appropriate for use in both ST-segment elevation myocardial infarction (STEMI) and non-STEMI patients, but it requires a calculator, an electrocardiogram, cardiac biomarkers, and serum creatinine levels, which may not be available at the first medical contact.<sup>3</sup> The thrombolysis in myocardial infarction score is easier to calculate than the GRACE score, but it also requires access to the cardiac biomarkers and an electrocardiogram.<sup>4</sup>

The present study aims to investigate the prognostic impact of BP and HR at admission on intrahospital prognosis of STEMI patients treated with primary percutaneous coronary intervention (PCI).

## Patients and methods

### Patient selection

Between January and April 2017, 326 patients with STEMI were admitted to the Cardiology Clinic of the Timisoara Institute of Cardio-Vascular Diseases. The hospitalization was done within the first 12 hours of the onset of the symptoms. Among them, 294 patients underwent primary PCI and were included in this study.

BP at admission was defined as the first BP, measured in a sitting or dorsal position, in the emergency room. Depending on systolic blood pressure (SBP) at admission, patients were classified into five groups: group I, with SBP  $\leq 105$  mmHg; group II, with SBP 105–125 mmHg; group III, with SBP 126–140 mmHg; group IV, with SBP 141–158 mmHg; and group V, with SBP  $\geq 159$  mmHg.

HR at admission was defined as the first HR determined in the hospital emergency room, in sitting or in “decubitus.” Increased HR was defined as values  $\geq 80$  beats per minute (bpm). We used the cutoff value of 80 bpm to define increased HR, as in clinical studies with STEMI patients undergoing primary PCI, an elevated HR (80 bpm or greater) identified those at increased risk of death.<sup>5</sup>

The diagnosis of STEMI was based on the presence of at least two of the following three criteria: 1) typical angina with duration of  $>20$  minutes; 2) the presence of ST-segment elevation  $\geq 1$  mV, with duration  $>0.08$  seconds measured from point J, in at least two adjacent leads; 3) transient increase in cardiac enzymes to at least twice the normal laboratory value.<sup>2</sup>

The study protocol was approved by the ethics commission of Timisoara Institute of Cardiovascular Diseases. Before enrollment, all patients signed the informed consent for participation in the study, according to Human Rights Declaration of Helsinki.

### Data extraction

Baseline data were extracted from hospital records and included age, gender, cardiovascular history, and risk factors, such as known ischemic heart disease, old MI, systemic hypertension, smoking, diabetes mellitus, hypercholesterolemia, and chronic kidney disease.

### Definition of covariates

Hypertension has been defined as systemic BP  $\geq 140/90$  mmHg or the use of antihypertensive agents.<sup>6</sup>

Hypercholesterolemia was defined as total cholesterol  $\geq 190$  mg/dL or the use of cholesterol-lowering medication.<sup>7</sup>

Diabetes mellitus was defined as fasting blood glucose  $\geq 126$  mg/dL or the use of antidiabetic treatment.<sup>8</sup>

Chronic kidney disease was defined in the presence of a glomerular filtration rate  $<60$  mL/min/1.73 m<sup>2</sup> body surface area, calculated using the Modification of Diet in Renal Disease (MDRD) Study Group equation.<sup>9</sup>

We used the classification of heart failure severity in patients with AMI proposed by Killip as following: class 1, with no clinical signs of heart failure; class 2, with rales in

the lungs, third heart sound, and elevated jugular venous pressure; class 3, with acute pulmonary edema; and class 4, with cardiogenic shock or arterial hypotension (measured as SBP <90 mmHg) and evidence of peripheral vasoconstriction (oliguria, cyanosis, and diaphoresis).<sup>10</sup>

## Primary PCI

Primary PCI was performed as a matter of urgency according to standard procedures. Significant coronary stenosis was defined in the presence of a reduction in internal diameter of at least 75% in the anterior descending, circumferential, or right coronary artery and at least 50% in the left coronary artery. Multivessel coronary artery disease (CAD) was defined in the presence of significant stenosis in several coronary arteries. After coronary angiography, percutaneous coronary angioplasty was performed in 294 patients.

## Follow-up and outcomes

The primary end point was in-hospital mortality, defined as death of any cause during the admission for STEMI.

Cardiac deaths were considered as those occurring due to cardiogenic shock, acute pulmonary edema, cardiac rupture, or ventricular fibrillation.

Noncardiac deaths were defined as deaths having an extracardiac cause, such as stroke, acute renal failure, or sepsis.

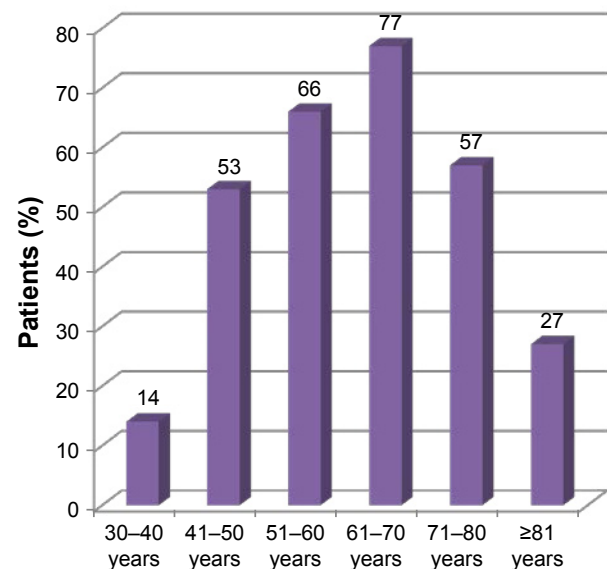
## Statistical analysis

The statistical analysis was performed using MedCalc Statistical Software version 12.7.7 (Ostend, Belgium). Continuous variables are presented as mean  $\pm$  standard deviation (SD) and categorical variables as number (n) and percentage (%). The five patient groups were compared using the chi-square test for the categorical variables and the independent *t*-test for the continuous ones. Relative risk (RR) and confidence interval (CI) of 95% of various parameters, related to intrahospital death, were estimated by univariate analysis. Parameters with statistically significant risk in univariate analysis were included in the multivariate analysis by logistic regression. For the independent predictors identified by multivariate logistical regression, receiver operating characteristic (ROC) analysis was performed. Values of  $P < 0.05$  were considered statistically significant.

## Results

### Baseline characteristics

Of the 294 patients with STEMI subjected to primary PCI, 218 (74%) were men. The average age was  $62 \pm 17$  years (33–95 years). The distribution by age group of patients with STEMI is shown in Figure 1.



**Figure 1** Distribution of STEMI patients by age groups.  
**Abbreviation:** STEMI, ST-segment elevation acute myocardial infarction.

According to the SBP at admission, STEMI patients were divided into five groups. The baseline characteristics and cardiovascular history and risk factors among the five patient groups are presented in Table 1. Compared to the other groups, group I patients (with SBP <105 mmHg at admission) were more often elderly ( $P=0.033$ ), smokers ( $P=0.026$ ), with a history of old MI ( $P=0.003$ ), systemic hypertension ( $P=0.023$ ), diabetes ( $P=0.041$ ), or chronic kidney disease ( $P=0.020$ ). They had more often a HR  $\geq 80$  bpm ( $P=0.028$ ) and a Killip class 3 or 4 at admission ( $P=0.020$ ). Group V patients, with SBP  $\geq 159$  mmHg at admission, were more frequently hypertensive and diabetic.

## Angiographic data

Table 2 presents the results of the emergency coronarography and the peak values of creatine phosphokinase (CPK)-MB. For patients in group I, the most common lesions responsible for the AMI were located in the right coronary artery, the left coronary artery trunk, or on more than two vessels, and the peak CPK-MB values were significantly higher.

## In-hospital mortality

During the hospitalization, 18 deaths (6%) occurred, 11 of them having a cardiac cause (3.7%) and the other seven having noncardiac causes (3.3%), as presented in Table 3.

The patients in group I ( $n=60$ ) had an intrahospital mortality rate of 15%, significantly higher than the rest of the groups ( $P=0.018$ ). Between the other groups, the differences in mortality rates were not significant.

**Table 1** Baseline characteristics and cardiovascular risk factors of STEMI patients

	Groups of STEMI patients by SBP (mmHg) at admission					P-value
	I, <105 (n=60)	II, 105–125 (n=58)	III, 126–140 (n=62)	IV, 141–158 (n=56)	V, ≥159 (n=58)	
Age (years, mean ± SD)	70±12	67±10	68±11	66±12	67±9	0.128
Age ≥65 years (%)	30 (50%)	18 (31%)	24 (38%)	16 (32%)	12 (22%)	<b>0.033</b>
Male (%)	44 (73%)	42 (74%)	47 (76%)	41 (74%)	44 (75%)	0.139
Previous MI (%)	12 (20%)	8 (15%)	6 (9%)	6 (9%)	2 (3%)	<b>0.003</b>
Smoking history (%)	25 (42%)	18 (31%)	25 (38%)	25 (45%)	10 (36%)	<b>0.026</b>
Hypercholesterolemia (%)	23 (38%)	23 (42%)	25 (41%)	25 (47%)	26 (45%)	0.050
Systemic hypertension (%)	31 (52%)	30 (53%)	36 (58%)	33 (59%)	42 (72%)	<b>0.023</b>
Diabetes mellitus (%)	12 (20%)	15 (26%)	15 (24%)	17 (31%)	26 (44%)	<b>0.041</b>
Chronic kidney disease (%)	30 (51%)	19 (33%)	17 (28%)	16 (29%)	16 (27%)	<b>0.020</b>
HR at admission (bpm, mean ± SD)	82±17	79±15	76±17	69±19	63±30	<b>0.002</b>
HR at admission ≥80 bpm (%)	37 (61%)	29 (51%)	32 (52%)	26 (47%)	19 (34%)	<b>0.028</b>
Killip 3/4 (%)	23 (39%)	15 (26%)	11 (18%)	9 (16%)	12 (20%)	<b>0.020</b>

**Note:** Statistically significant values are shown in bold ( $P < 0.05$ ).

**Abbreviations:** STEMI, ST-segment elevation acute myocardial infarction; SBP, systolic blood pressure; SD, standard deviation; MI, myocardial infarction; HR, heart rate; bpm, beats per minute.

Cardiac deaths occurred significantly more frequently in group I ( $P=0.032$ ), whereas noncardiac events had a similar distribution in the five groups.

In patients who had SBP <105 mmHg at admission, the RR of death due to any cause was 4.9 (95% CI 1.977–12.205,  $P=0.006$ ), and the RR of cardiac death was 5.4 (95% CI 1.723–17.249,  $P=0.003$ ; Table 3).

HR ≥80 bpm is another predictive parameter of the increased risk of death in patients with STEMI, as outlined in Table 4.

The multivariate logistic regression analysis selected those variables with independent predictive power for the risk of in-hospital death. These independent variables are highlighted in Tables 5–7.

We compared the predictive power of the selected independent variables using the ROC curves, analyzing the area under the curve (AUC). The graphs representing the ROC curves are shown in Figures 2 and 3.

Regarding the risk of death in post-PCI STEMI patients, the best predictor was SBP ≤105 mmHg (AUC =0.804, 95% CI 0.712–0.896,  $P < 0.0001$ ), followed by diabetes mellitus (AUC =0.697, 95% CI 0.582–0.813,  $P=0.0013$ ), HR ≥80 bpm (AUC =0.664, 95% CI 0.541–0.747,  $P=0.0272$ ), and history of hypertension (AUC =0.554, 95% CI 0.439–0.670,  $P=0.0009$ ).

Significant differences between areas under the ROC curves, which indicate significant differences between predictive capacities, were also observed for diabetes mellitus and history of hypertension (0.143, 95% CI 0.0033–0.283,  $P=0.044$ ).

In the case of post-PCI STEMI cardiac death risk, the strongest predictor was Killip class ≥3 at admission (AUC =0.896, 95% CI 0.872–0.919,  $P=0.0429$ ), followed by SBP ≤105 mmHg (AUC =0.791, 95% CI 0.669–0.913,  $P=0.0057$ ), HR ≥80 bpm (AUC =0.756, 95% CI 0.727–0.785,  $P=0.0023$ ), and multivascular CAD (AUC =0.648, 95% CI 0.498–0.798,  $P=0.0015$ ).

**Table 2** Angiographic findings and peak values of CPK-MB

Culprit lesions	Groups of STEMI patients by SBP (mmHg) at admission					P-value
	I, <105 (n=60)	II, 105–125 (n=58)	III, 126–140 (n=62)	IV, 141–158 (n=56)	V, ≥159 (n=58)	
RCA (%)	31 (52%)	25 (43%)	20 (33%)	18 (32%)	12 (21%)	<b>0.005</b>
LAD (%)	15 (25%)	23 (40%)	29 (49%)	28 (50%)	35 (62%)	<b>&lt;0.001</b>
LCX (%)	6 (10%)	7 (12%)	9 (14%)	8 (15%)	10 (17%)	0.842
LMT (%)	6 (10%)	1 (1%)	1 (1%)	1 (2%)	1 (1.5%)	<b>0.040</b>
Multivessel CAD (%)	7 (11%)	2 (3%)	2 (2.5%)	1 (2.9%)	1 (2%)	<b>0.044</b>
Peak value of CPK-MB (IU/L, mean ± SD)	579±852	295±251	268±236	257±234	248±269	<b>0.005</b>

**Note:** Statistically significant values are shown in bold ( $P < 0.05$ ).

**Abbreviations:** STEMI, ST-segment elevation acute myocardial infarction; SBP, systolic blood pressure; SD, standard deviation; RCA, right coronary artery; LAD, left anterior descending coronary artery; LCX, left coronary circumflex artery; LMT, left main trunk; CAD, coronary artery disease; CPK, creatine phosphokinase; MB, myocardial B subunit isoenzyme; IU, international units.

**Table 3** In-hospital mortality

	Groups of STEMI patients by SBP (mmHg) at admission					P-value
	I, <105 (n=60)	II, 105–125 (n=58)	III, 126–140 (n=62)	IV, 141–158 (n=56)	V, ≥159 (n=58)	
All-cause deaths: 18 (6%)	9 (15%)	2 (3.4%)	3 (4.8%)	2 (3.5%)	2 (3.3%)	<b>0.018</b>
Cardiac deaths: 11 (3.7%)	6 (10%)	1 (1.7%)	2 (3.2%)	1 (1.7%)	1 (1.6%)	<b>0.032</b>
– Shock	3	1	1	1	0	
– Acute pulmonary edema	2	0	1	0	1	
– Cardiac rupture	1	0	0	0	0	
– Ventricular fibrillation	0	0	0	0	0	
Noncardiac deaths: 7 (2.3%)	3 (5%)	1 (1.7%)	1 (1.6%)	1 (1.7%)	1 (1.6%)	0.297
– Stroke	2	0	1	0	1	
– Acute renal failure	1	1	0	1	0	

**Note:** Statistically significant values are shown in bold ( $P<0.05$ ).

**Abbreviations:** STEMI, ST-segment elevation acute myocardial infarction; SBP, systolic blood pressure.

Significant differences between the areas under the ROC curves were observed for HR  $\geq 80$  bpm versus the Killip class  $\geq 3$  (0.140, 95% CI 0.106–0.173,  $P<0.0001$ ) and for the Killip class  $\geq 3$  versus multivessel CAD (0.248, 95% CI 0.0955–0.399,  $P=0.0014$ ).

## Discussion

Early post-AMI mortality is an important indicator of hospital and health performance. Therefore, the efficacy of the AMI treatment has been studied in several randomized trials, but with several limitations. Thus, a study involving STEMI patients in 12 European countries reported an increased use of primary PCI but pointed out that there are considerable differences between states.<sup>11</sup> A number of regional differences related to the organization of the health system, procedures, and health programs, and which are associated with prognosis, were not included in the evaluation.<sup>12,13</sup> International studies on AMI cannot have a unitary vision based on the selected data from hospitals and those reported in national registers. There are also no unitary criteria for assessing mortality.

**Table 4** RR of in-hospital death according to SBP at admission

SBP (mmHg)	Deaths	RR	95% CI	P-value
<105	All causes	4.912	1.977–12.205	<b>0.0060</b>
	Cardiac causes	5.452	1.723–17.249	<b>0.0039</b>
105–125	All causes	0.327	0.077–1.380	0.1284
	Cardiac causes	0.251	0.032–1.922	0.1284
126–140	All causes	1.452	0.386–5.311	0.5724
	Cardiac causes	0.863	0.191–3.896	0.8485
141–158	All causes	1.098	0.239–5.031	0.9040
	Cardiac causes	0.432	0.056–3.306	0.4195
$\geq 159$	All causes	0.543	0.128–2.296	0.4069
	Cardiac causes	0.439	0.057–3.361	0.4282

**Note:** Statistically significant values are shown in bold ( $P<0.05$ ).

**Abbreviations:** SBP, systolic blood pressure; RR, relative risk; CI, confidence interval.

Our retrospective study is the first study in Romania addressing the prognostic impact of HR and SBP at admission on STEMI patients undergoing primary PCI. The results show that these easily determinable clinical parameters are independent predictors of intrahospital mortality.

BP is the measured result of the interactions between numerous and complex factors that control blood vessel size, as well as their response to neurohormonal stimuli and cardiac output. Neurohormonal stimuli can induce hypertension by increasing systolic flow and/or peripheral vascular resistance. There is much evidence that a sustained increase in BP is, at any age, an independent factor of cardiovascular risk.<sup>14</sup>

The predictive value of HR for CAD mortality risk is higher in hypertensive than in normotensive patients. There is evidence that hypertensive patients with HR  $>80$  bpm have a higher risk than those with HR  $<60$  bpm.<sup>15</sup> Therefore, HR has a major role in the occurrence and maintenance of hypertension. Increased HR at rest is associated with an increased risk of total and cardiovascular mortality, regardless of age, race, sex, presence of diabetes, or cardiovascular disease.<sup>16</sup>

The first major evaluation of HR in relation to classical cardiovascular risk factors, including hypertension, was conducted by a study in France. Subjects with HR  $\geq 85$  bpm had a SBP 12 mmHg higher and a diastolic BP 7 mmHg higher when compared to those with HR  $<65$  bpm.<sup>17</sup>

**Table 5** RR of in-hospital mortality according to HR at admission

	Deaths	RR	95% CI	P-value
HR $\geq 80$ bpm	All causes	8.680	2.032–37.084	<b>0.0035</b>
	Cardiac causes	10.629	1.378–81.987	<b>0.0234</b>

**Note:** Statistically significant values are shown in bold ( $P<0.05$ ).

**Abbreviations:** HR, heart rate; bpm, beats per minute; RR, relative risk; CI, confidence interval.



**Table 6** RR of all-cause deaths in STEMI patients

Independent predictors	RR	95% CI	P-value
SBP <105 mmHg at admission	4.278	4.193–47.350	<0.0001
HR ≥80 bpm at admission	3.406	1.148–10.104	0.0272
History of systemic hypertension	5.790	0.5780–4.3431	0.0009
Diabetes mellitus	4.758	1.845–12.273	0.0013

**Abbreviations:** STEMI, acute myocardial infarction with ST-segment elevation; SBP, systolic blood pressure; HR, heart rate; bpm, beats per minute; RR, relative risk; CI, confidence interval.

The Chicago epidemiological study demonstrated a clear association between hypertension and HR, this association being more important for SBP.<sup>18</sup>

Increased HR is associated with endothelial dysfunction, accelerated atherosclerosis, and an increased risk of cardiovascular mortality, especially in the presence of acute coronary syndromes.<sup>19</sup> In our study, the mean HR was 75±18 bpm in post-PCI STEMI survivors, 89±15 in the case of in-hospital deaths of all causes (P=0.0423), and 92±12 bpm in the patients with cardiac deaths (P=0.0021).

A HR ≥80 bpm increased 3.4 times the risk of in-hospital death of any cause (P=0.027) and doubled the risk of cardiac death (P=0.028). It proved to be an independent predictor of intrahospital mortality in STEMI patients who performed primary PCI. These results are concordant to those of the Goteborg study, which showed a threefold death risk in subjects with HR =90–99 bpm compared to those with HR ≤60 bpm.<sup>20</sup>

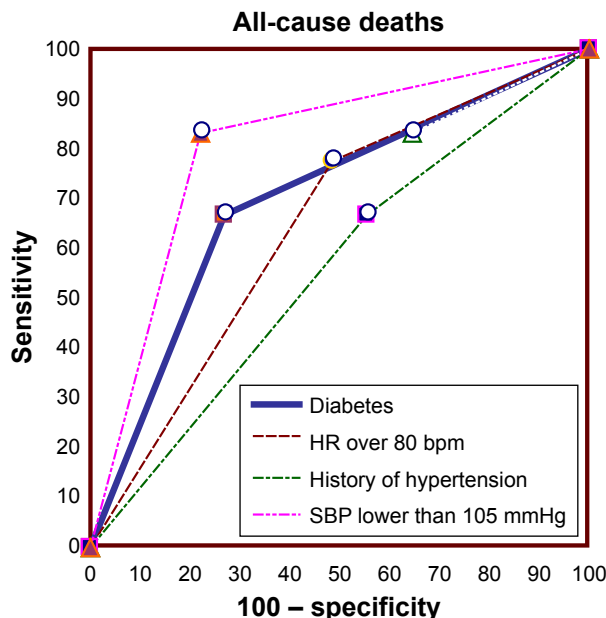
An even stronger predictor was SBP at admission. It had an average value of 136±24 mmHg for the entire group of STEMI patients. The mean SBP was 139±22 mmHg in survivors and 110±35 mmHg in those who died (P<0.0001). SBP at admission <105 mmHg increased 4.9 times the risk of all-cause death (P=0.0060) and 5.4 times the risk of cardiac death (P=0.0039).

A series of studies have shown that prognosis is better in patients with AMI who have a higher BP at admission.<sup>21–25</sup> SBP is included in several acute coronary syndrome prognosis scores.<sup>26–32</sup> SBP being the result of interaction between peripheral vascular resistance and cardiac output, a higher

**Table 7** RR of all cardiac-related deaths in STEMI patients

Independent predictors	RR	95% CI	P-value
SBP <105 mmHg at admission	3.297	2.801–57.406	0.0010
HR ≥80 bpm at admission	2.197	1.410–41.98	0.0280
Killip 3/4	3.073	5.040–94.064	0.0021
Multivessel CAD	3.243	2.126–21.3147	0.0012

**Abbreviations:** STEMI, acute myocardial infarction with ST-segment elevation; SBP, systolic blood pressure; HR, heart rate; bpm, beats per minute; CAD, coronary artery disease; RR, relative risk; CI, confidence interval.

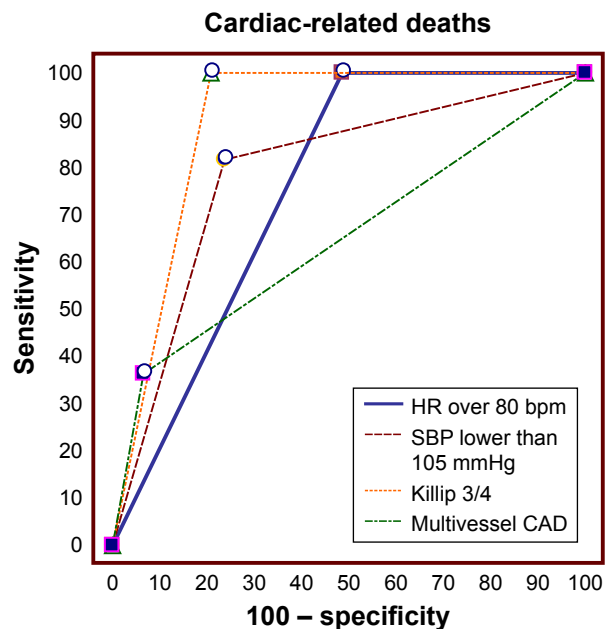


**Figure 2** Comparison of receiver operating characteristic curves of independent variables predictive of in-hospital all-cause death risk.

**Abbreviations:** HR, heart rate; bpm, beats per minute; SBP, systolic blood pressure.

admission value reflects not only higher peripheral systemic resistance but also a better systolic ventricular function due to lower myocardial injury.

In our study, mortality was significantly higher in group I, which included STEMI patients with SBP <105 mmHg, compared to the other four subsets of SBP values.



**Figure 3** Comparison of receiver operating characteristic curves of independent variables predictive of in-hospital cardiac-related death risk.

**Abbreviations:** HR, heart rate; bpm, beats per minute; SBP, systolic blood pressure; CAD, coronary artery disease.

Patients in group I (n=60), with the highest mortality (15%), were more frequently elderly ( $\geq 65$  years), with a history of MI and chronic kidney disease. They had admission HR  $\geq 80$  bpm, Killip classes  $\geq 3$ , and high CPK values more often. Angiographic data in these patients revealed more frequently involvement of the left main trunk or multivessel CAD.

The lowest mortality (3.3%) was recorded in group V (SBP  $\geq 159$  mmHg), in which STEMI patients were younger, nonsmokers, and more often hypertensive and diabetic. They had lower CPK-MB values, and the culprit lesion was found more frequently on the left anterior descending coronary artery.

In group I, cardiac deaths were twice as common as non-cardiac causes (10% vs 5%,  $P=0.3$ ), whereas in group V, the two types of deaths had equal frequencies (1, 6%).

In our study, HR  $\geq 80$  bpm and SBP  $< 105$  mmHg were the only variables that predicted both all-cause and cardiac-related death risk in STEMI patients after primary PCI. Systemic hypertension and diabetes mellitus were independent predictors only for all-cause deaths, while Killip  $\geq 3$  class at admission and multivessel CAD were independent predictors for cardiac-related deaths.

## Study limitations

This is a retrospective observational study conducted at a single hospital for a period of 4 months and included a relatively small number of patients, with a low number of in-hospital events. The study did not include data regarding prehospital and in-hospital treatment, ischemic time (from onset of symptoms to coronary angioplasty), left ventricular ejection fraction, major nonfatal cardiovascular events occurred during hospitalization, and mortality at 30 days and at 1 year.

## Conclusion

Our study suggests that vital signs (HR and SBP) reported on admission of STEMI patients can provide valuable information on the risk of in-hospital death after primary PCI.

Thus, HR  $\geq 80$  bpm and SBP  $\leq 105$  mmHg correlate with an increased risk of death, while HR  $< 80$  bpm and SBP  $\geq 159$  mmHg are associated with a better prognosis.

## Author contributions

All authors contributed toward data analysis, drafting and critically revising the paper, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

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