Can the in-hospital mortality rate in patients with ST-elevation myocardial infarctions be lowered any further?

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Abstract

Background. A myocardial infarction is a specific clinical condition characterized by a relatively high acute mortality rate. Earlier reperfusion results in a smaller infarct size and a lower mortality rate.

Objectives. To assess the in-hospital mortality in patients with ST-elevation myocardial infarction (STEMI) regarding patients' characteristics, and the mechanisms behind the deterioration in hemodynamic and clinical status, in order to assess the possibility of preventing this type of death.

Material and methods. A group of 106 patients aged 64.5 ±11.3 years was divided into 2 groups: patients who died while hospitalized (group I; n = 5) and patients who survived while hospitalized for STEMI (group II; n = 101). Primary coronary intervention was performed in all individuals, with direct stent implantation in all but 1 patient. In all patients the standard medication was started or continued, depending on the patient's status. The demographic and selected clinical and biochemical parameters were compared between the study groups.

Results. The patients in group I were significantly older than the survivors (76.2 ±12.7 compared to 64.0 ±11.0 years; $p < 0.05$). The group with fatal myocardial infarction had a lower left ventricular ejection fraction (LVEF) (31.7 ±12.8% compared to 60.4 ±11.0%; $p < 0.05$) and a higher maximal serum troponin level (973.6 ±1121.8 ng/mL compared to 453.2 ±924.2 ng/mL; $p < 0.05$). Interestingly, among the patients who died, the pain-to-balloon time was significantly shorter than in the myocardial infarction survivors (84 ±48 min compared to 342 ±504 min; $p < 0.05$).

Conclusions. The development of the medical care system has made invasive procedures available, improving outcomes in patients with acute myocardial infarction. This form of treatment is likely optimized to such an extent that any changes in the time before intervention will not substantially improve mortality rates.

Key words: myocardial infarction, in-hospital mortality, ST-elevation myocardial infarction, primary percutaneous coronary intervention

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Background

Myocardial infarction is a specific clinical disorder characterized by a relatively high acute mortality rate.[1] Multiple mechanisms contribute to arrhythmia and hemodynamic episodes, leading to cardiomyocyte ischemia and even the relatively sudden death of the individual.[2] The distinction between ST-elevation and non-ST-elevation made little change in the clinical picture of in-hospital mortality. The most spectacular and fearful type of death is a sudden arrhythmic one in the form of ventricular fibrillation. The other possibility is an acute, high-degree atrioventricular blockage. There are 2 main forms of blockage: in patients with an inferior wall myocardial infarction, the most common type is a transient, proximal atrioventricular block, usually with a relatively rapid, narrow QRS escape rhythm, while in patients with an extensive anterior myocardial infarction, it is caused by interventricular septum ischemia, a typically permanent, distal type with a low, broad QRS escape rhythm. The latter can lead to ventricular asystole and sudden death. The hemodynamic impairment of ischemic ventricular myocardium can also result in low cardiac output with clinical signs of cardiogenic shock. This disorder was historically associated with a very poor prognosis, with mortality rates as high as 90%. An appropriate, timely invasive treatment of the underlying myocardial infarction can of course substantially reduce the burden of ischemia and necrosis.[3] However, in some individuals, the changes could be irreversible, which can also lead to in-hospital death.

A report on the care of patients with ST-elevation myocardial infarction (STEMI) in American hospitals showed an improvement in care manifested by an increase in the rate of reperfusion and a shortening of the time from symptom onset to treatment. At the same time, several years of observation did not show a decrease in mortality in the entire study population, but only for patients without cardiac arrest. In the whole population, cardiogenic shock and cardiac arrest steadily increased.[1] When designing our study, we wanted to know the profile of STEMI patients in our center, and the mortality rate and characteristics of the group with the highest risk. The modern cardiac care of patients with STEMI diminished the acute mortality to as low as 4–5%. It is uncertain if this value can be substantially reduced. One of the key obstacles is the numerous comorbidities related to the increasing age of the patients. Various combinations of chronic kidney disease (CKD), diabetes mellitus (DM), chronic atrial fibrillation, chronic obstructive pulmonary disease (COPD), malnutrition, frailty, and cognitive function decline can negatively influence the outcome in myocardial infarction patients even if the infarct-related artery (IRA) is kept open.[4] Partial or slight insufficiencies of the aforementioned organs and systems in connection with even benign and transient hemodynamic impairment can contribute to a fatal end result – in-hospital death.

The aim of the study was to assess the in-hospital death rate in patients with STEMI in relation to the patients' characteristics, and the mechanisms of deterioration in hemodynamic and clinical status, in order to assess the possibility of preventing this type of death.

Material and methods

The study group comprised all patients hospitalized in 2015 with a diagnosis of STEMI in the regional cardiology ward, featuring a permanently working cardiac catheterization laboratory (Cath Lab). All patients were treated directly in the Cath Lab, undergoing primary coronary angioplasty, usually with a concomitant stent placement. These individuals were divided into 2 subgroups according to in-hospital death. Of the 106 patients included, 5 died during the hospitalization.

The study was approved by the local Bioethics Committee at Wroclaw Medical University, Poland.

Statistical analysis

All continuous variables are presented as means and standard deviations (SD). Comparisons were performed with the Mann–Whitney U test for independent groups. All categorical variables are presented as numbers and percentages. The comparisons were performed with the χ^2 test. P-values less than 0.05 were considered significant.

Results

The basic demographic characteristics and selected clinical and biochemical data are presented in Tables 1 and 2. The difference in ejection fraction between the 2 groups is depicted in Fig. 1.

In the 5 patients who died, the LAD was occluded or subtotally narrowed in 4 cases. The circumflex artery (Cx)

Table 1. The patients' demographic and selected clinical data

Variable	Died (n = 5)	Survived (n = 101)	p-value
Age [years]	76.2 ±12.7	64.0 ±11.0	<0.05
Sex [% female]	20	34	n.s.
Pain-to-balloon time [min]	84 ±48	342 ±504	<0.05
RR syst. [mm Hg]	114.0 ±27.0	137.2 ±28.6	n.s.
Pulse [bpm]	95.3 ±21.7	77.3 ±18.5	n.s.
EF [%]	31.7 ±12.8*	60.4 ±11.0	<0.05
AF [%]	20	4	n.s.
DM/IFG/IGT [%]	40	28	n.s.
Hypertension [%]	60	60	n.s.

*n = 4; EF – ejection fraction; AF – atrial fibrillation; DM – diabetes mellitus; IGF – impaired fasting glucose; IGT – impaired glucose tolerance; RR syst. – systolic blood pressure.

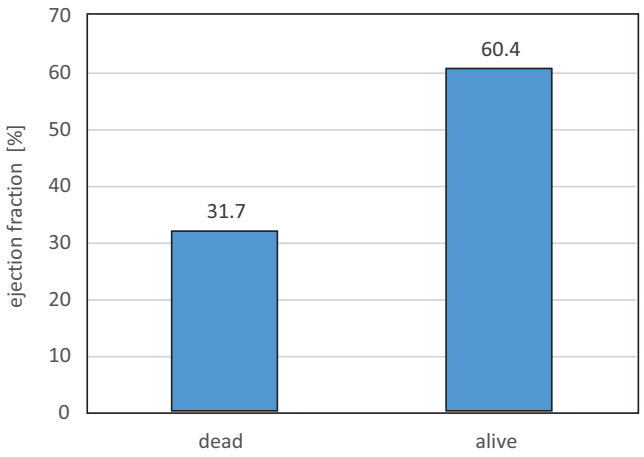

Fig. 1. Comparison between the study groups according to EF

or the right coronary artery (RCA) was occluded or subtotally narrowed in 3 cases. In 4 cases, the primary percutaneous coronary intervention (PCI) was successful; in 1 patient, pulseless electrical activity was observed before the intervention, which was therefore postponed and subsequently not performed.

Selected biochemical parameters in the study groups are presented in Table 2.

Table 2. Patients' biochemical data

Variable	Died (n = 5)	Survived (n = 101)	p-value
Troponin I [ng/mL]	973.6 ±1121.8	453.2 ±924.2	<0.05
Creatinine [mg%]	1.1 ±0.3	1.0 ±0.3	ns.
Glucose [mg%]	148.2 ±54.1	160.6 ±62.2	ns.

ns. – not significant.

Discussion

The implementation of optimal treatment methods in patients with STEMI has led to a significant improvement in the survival rate to the degree that may constitute the limits of medical care. The combination of advanced age, pre-existing myocardial damage, serious co-morbidities, and recent widespread myocardial ischemia can prove fatal despite modern and sophisticated treatment modalities.

In accordance with data from the literature, our study demonstrated that the age of the patients determined their mortality. This parameter is important in all acute coronary syndromes (ACS). Older people usually have more advanced atherosclerosis, and higher rates of co-morbidities and cardiovascular risk factors, which place them at a higher risk of an extensive coronary artery disease (CAD) than younger individuals.[2–4] The STEMI is the most serious condition of all CAD presentations. Previous studies have suggested that older STEMI patients were at a higher risk of death and other complications regardless of the treatment used.[5]

Our study was conducted among patients with optimal treatment, since they were taken directly to the Cath Lab by emergency medical services. Previous studies have demonstrated that PCI was superior to thrombolysis in terms of re-infarction, stroke and death. If those most appropriate treatments had been offered within the shortest possible time from symptom onset, it would have dramatically improved the clinical outcome compared to conservative treatment strategies. In the present study, all patients had angioplasty of the IRA. The time to the procedure in our group with the fatal outcome was not significantly longer than in the group of survivors. It is likely that the patients with a fatal infarction had a shorter pain-to-balloon time because of the most severe symptoms.

One of possible reasons for death during a STEMI could be concomitant changes in other arteries than the IRA. The prognosis of a patient is related to the extent of ischemia due to the occlusion of the blood vessel. Therefore, the location of the lesion and changes in other vessels are important, as the closure of the artery responsible for collateral circulation may affect a wide area of the myocardium. About 40–65% of the patients presenting with STEMI are found to have a co-existing disease in the non-infarct-related arteries. The 2017 European Society of Cardiology (ESC) guidelines for patients with STEMI recommend PCI of the non-culprit artery at the time of primary PCI as a class IIa (strong) recommendation if the patient is hemodynamically stable.[6] There are several studies showing that a complete revascularization (immediate and/or staged) is associated with a significant reduction in events, mainly driven by a significant reduction in the rates of repeat revascularization and cardiac death when compared to IRA-only revascularization in patients with STEMI and a concomitant multi-vessel disease.[7]

Our patients who died during hospitalization had a higher heart rate and a lower blood pressure at admission, although these differences were not statistically significant. These findings are consistent with other studies. An observational study on 2,310 STEMI patients treated with primary PCI showed that an elevated heart rate on admission was an independent prognostic factor for in-hospital and long-term mortality.[8,9] A higher heart rate in combination with a lower blood pressure can predict the development of cardiogenic shock, significantly increasing mortality in ACS.

The extent of ischemia can be expressed by certain biomarkers, including troponin. Troponin level is positively and proportionally related to the extent of myocardium damage. In patients with ACS, the troponin level on admission is an independent predictor of death.[10,11] However, The prognostic value of troponin level on admission in patients with STEMI is not unambiguous. In a study by Stubbs et al., patients with higher troponin levels on admission had worse outcomes of thrombolytic therapy, but the differences in early mortality were not statistically significant.[12] The same observation was made

in a different study, in a population treated with angioplasty, where higher troponin levels predicted a worse outcome of this treatment as well.[11] In the present study, the group with an unfavorable outcome had significantly higher serum troponin levels on admission. This finding is in concordance with the consensus and with previous studies.[13] The association was proven to be true, not only in the acute phase, but also in the healing phase of myocardial infarction, when the highest troponin levels predicted all-cause death.[14] The correlation appears in ACS as well as in different clinical statuses, where a cardiac troponin level combined with a higher incidence of regional wall motion abnormalities predicts death.[15]

As a result of this injury, the authors showed echocardiographic features of worse cardiac muscle performance. Patients who died during hospitalization had a significantly lower ejection fraction of the left ventricle (LVEF), which has been observed in many previous studies. A subsequent cohort study by Vakili et al., which included 304 STEMI patients reperfused with primary PCI, showed that LVEF ≤50% was associated with high rates of in-hospital adverse events, including death.[16] Perelshtein Brezinov et al. in their recent study presented LVEF as a very strong predictor of mortality in ACS,[17] which was also the case in our group. The same correlations were shown in previous studies, such as the one by Falcão et al. where the ejection fraction (EF) in patients with STEMI was an independent factor of in-hospital mortality. In a group of 398 patients, the in-hospital mortality was comparable to the one presented in our study, i.e., 5.8%.[18] An interesting analysis of the prognostic value of EF in patients with ACS was presented by Perelshtein Brezinov et al.[17] The patients were categorized according to LVEF at admission, and it was found that the prognosis in those with severe LV dysfunction is mainly related to clinical factors (syncope and STEMI) and clinical instability on admission. In the group with a more preserved EF, the presence of comorbidities predicted a mortality risk.

Anemia is a marker of a poor prognosis in ACS. In a study on a group of 1,111 patients with STEMI who received reperfusion treatment, hemoglobin levels were associated with a better survival rate. The association of hemoglobin with hospital mortality was seen in men and women 65 or older.[19] Our observations were consistent, but not statistically significant. The group with the fatal complication of STEMI was small, but with a larger sample statistical significance of such findings would be possible. The same findings were presented in the recently published STEMI registry (1,498 patients). In this group, anemic and non-anemic patients were compared, as a result of which the in-hospital mortality rate was observed to be significantly higher in the patients with anemia. The population characteristics also revealed a gradual increase in mean age with lower hemoglobin levels.[20] The probable explanation for this coexistence is the worse overall health of the elderly population.

Study limitations

The main limitation of the study is the small sample size, especially in the group of patients who died while hospitalized, but this is actually the result of a shift in the management of patients with ACS towards more aggressive, invasive interventions. While in the 1990s, a pre-hospital mortality of 25% was reported, and a risk of in-hospital death was <10%, including a similar risk of cardiogenic shock in these patients, in the 2010s, changes in treatment and organization led to the results presented in this study. Therefore, the question asked in the title – "Can the in-hospital mortality rate in patients with ST-elevation myocardial infarctions be lowered any further?" – is an attempt to assess the profile of patients in the study group. The only potential way to increase the positive impact of our work would be new, non-standard therapies applied in the acute phase of myocardial infarction, using new drugs or a new way to administer them.[21]

Conclusions

It is not possible to significantly reduce the in-hospital mortality of STEMI patients who have been successfully treated with primary PCI, despite all modern treatment modalities. The combination of advanced age and numerous comorbidities – including pre-existing low LV ejection fraction – makes in-hospital death inevitable, despite an early and successful myocardial reperfusion. From the clinical point of view, to lower the mortality in patients with CAD, the atherosclerosis risk factors must be substantially modified in primary and secondary prevention.

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