Original article

Kardiologia Polska
2011; 69, 1: 33–39
ISSN 0022–9032

# The significance of anaemia in patients with acute ST-elevation myocardial infarction undergoing primary percutaneous coronary intervention

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## Abstract

**Background:** The effects of pre-existing anaemia on the occurrence and course of an acute coronary syndrome has recently become a topic of extensive research. The data on the significance of anaemia in patients with ST-elevation myocardial infarction (STEMI) undergoing percutaneous coronary intervention (PCI) are less abundant and the conclusions equivocal.

**Aim:** To evaluate the incidence of anaemia and its impact on early outcomes in patients undergoing primary PCI for STEMI.

**Methods:** Based on a retrospective review of the medical records of hospitalised patients we selected a study group comprising 551 consecutive patients with STEMI, including 164 females, mean age 63.4 ± 12 years, undergoing primary PCI within the first 12 hours after the onset of chest pain. Anaemia was diagnosed according to the World Health Organisation criteria based on haemoglobin (Hb) values on admission (< 12 g/dL for females, < 13 g/dL for males).

**Results:** Anaemia was diagnosed in 61 (11%) patients (in 13% of females and 10% of males). The anaemic patients were older (71 *vs* 63 years, $p < 0.001$), had a lower body mass (70 *vs* 80 kg, $p < 0.003$) and a higher TIMI risk score for STEMI (5 *vs* 3, $p < 0.0001$). Their laboratory results showed a greater renal impairment (GFR 66.8 *vs* 75.8 mL/min, $p < 0.008$) and higher C-reactive protein levels (24.8 *vs* 14.4 mg/L, $p < 0.001$). There were no significant differences in post-infarction myocardial damage as estimated on the basis of ejection fraction and the baseline and peak CK-MB levels. During treatment, in both groups, there was a significant decrease in Hb levels from 11.9 to 11.0 g/dL in the anaemic patients ($p < 0.0004$) and from 14.3 to 13.3 g/dL in the non-anaemic patients ($p < 0.001$). While GFR did not change significantly in the anaemic patients, there was a significant increase in the non-anaemic patients from 75.8 to 80.9 mL/min ($p < 0.001$). The in-hospital mortality was low with a total of 8 (1.3%) patients dying: 5 (8.2%) in the anaemic group and 3 (0.6%) in the non-anaemic group ($p < 0.001$). The anaemic patients were also characterised by a higher incidence of cardiovascular complications (33% *vs* 17%, $p = 0.003$). In the multivariate analysis, older age, systolic blood pressure on admission and elevated white blood count were independently associated with a higher risk of death and cardiovascular complications, whereas baseline Hb level was a significant prognostic factor only in the univariate analysis.

**Conclusions:** Patients with anaemia who develop STEMI are, right from the admission, a separate, higher-risk population of patients with considerably increased risk of death and in-hospital cardiovascular complications. The unfavourable impact of anaemia on outcomes in patients with acute MI undergoing PCI is complex and cannot be explained by the increased extend of post-infarction myocardial damage. In patients with STEMI, anaemia on admission should be treated as an additional risk factor.

**Key words:** anaemia, ST-elevation myocardial infarction, primary percutaneous coronary intervention

Kardiol Pol 2011; 69, 1: 33–39

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**Received:** 30.08.2010 **Accepted:** 20.10.2010

## INTRODUCTION

According to various sources, anaemia is present in 15–30% of patients with acute coronary syndrome (ACS) and became a topic of extensive research only a few years ago. As in heart failure (HF), anaemia adversely affects the outcomes of ACS [1–3]. The significance of anaemia in ACS, particularly in the era of widespread percutaneous coronary interventions (PCI) and an increasingly effective antiplatelet treatment, has generated interest among many researchers in the past decade [4, 5]. The majority of publications addressing anaemia in ACS have focussed on the significance of haemorrhagic complications during the treatment of myocardial infarction (MI) and on the prognostic significance of transfusions [6–8]. Less attention has been devoted to the significance of anaemia discovered upon the diagnosis of ACS.

The aim of the study was to evaluate the incidence of anaemia diagnosed on admission and its impact on outcomes in patients undergoing PCI for ST-elevation MI (STEMI).

## METHODS

This was a retrospective analysis of medical records of patients hospitalised in our department between May and December 2005. We included consecutive patients with the diagnosis of STEMI who underwent PCI (primary percutaneous transluminal coronary angioplasty [PTCA] with or without stenting) within 12 hours after the onset of chest pain.

The diagnosis of STEMI was made on the basis of the typical clinical presentation, an ST elevation on ECG of more than 20 minutes' duration (in two adjacent leads, > 0.2 mV for precordial leads and > 0.1 mV for the remaining leads) and elevated levels of myocardial injury markers (the creatinine kinase MB fraction [CK-MB]).

Patients underwent PCI right after admission, using femoral approach and in accordance with the commonly recognised standards (using standard 6 F Judkins catheters). Anaemia was identified based on full blood count results on admission, in accordance with the World Health Organisation definition (haemoglobin [Hb] < 12 g/dL in females and < 13 g/dL in males) [9]. The group of anaemic patients was compared with that of non-anaemic patients in terms of demographic, clinical and laboratory parameters.

### *Analysed parameters*

We analysed: demographic parameters: age, sex, body mass; historical data: current and past illnesses, duration and severity of coronary artery disease, smoking status; hospitalisation-related data: infarct location, duration of the chest pain before admission, blood pressure and haemodynamic status on admission according to Killip's classification, TIMI risk score for STEMI (developed by Morrow and Antman), duration of hospitalisation at the Intensive Coronary Care Unit (ICCU); deaths and in-hospital cardiovascular (CV) complications (cardiac arrest, shock, myocardial rupture, pulmonary oedema, life-threatening cardiac arrhythmias and conduction disorders); ejection fraction (EF) assessed by echocardiography using the visual method within the first 24 hours after admission; laboratory parameters (full blood counts on admission and the lowest Hb level during the entire hospitalisation, the myocardial injury marker CK-MB, C-reactive protein [CRP], and the baseline and lowest glomerular filtration rate [GFR] values calculated from the Cockcroft-Gault formula).

### *Statistical analysis*

Quantitative variables with a normal distribution are presented as mean and SD, and quantitative variables without a normal distribution — as median, quartiles, maximum and minimum. The normality of the distribution was verified with the Kolmogorov-Smirnov and Lilliefors test for normality. We used the $\chi^2$ test of independence to check the relationship between the qualitative variables. We compared ordinal variables using the non-parametric U Mann-Whitney test in the case of two groups and the non-parametric Kruskal-Wallis ANOVA rank test with a post-hoc multiple comparison mean rank test for all the samples in the case of multiple groups. We also determined a Spearman's rank order correlation coefficient. We carried out univariate logistic regression for the analysed features and determined the multiple logistic regression model. Statistically significant results were at the p value of $< 0.05$. We used Statistica 8.0 (StatSoft) for our calculations.

## RESULTS

A total of 551 patients with the diagnosis of STEMI who underwent primary PCI within the first 12 hours after the onset of chest pain were included in the study (mean age 63.4 ± ± 12 years, 164 women [30% of the analysed population]). These were patients with multiple risk factors: overweight (median BMI 28 kg/m$^2$), more than a half of the patients (52%) had hypertension, 16% had diabetes mellitus, 12% had a history of MI and 7% had a history of stroke. Nearly half (42%) of the patients were smokers.

Based on the Hb levels on admission we identified a group of 61 (11%) patients with anaemia, 22 women and 39 men. Most patients had mild anaemia. Haemoglobin was below 10 g/dL in only 1 (1.6%) patient, 10.9–11.9 g/dL in 31 (50.8%) patients, and 12.0–13.0 g/dL in the remaining 29 (47.6%) patients. Based on a retrospective analysis of the medical records the cause of anaemia on admission could be established in only 32 patients. In 26 patients it was anaemia of chronic disease (mainly gastrointestinal disease, chronic kidney disease and locomotor system disorders) and in 6 patients it was iron deficiency anaemia. In the remaining 29 patients, based on the analysis of full blood cell counts, we established the presence of normocytic anaemia at unknown origin.

**Table 1.** Demographic and clinical parameters in patients with and without anaemia

| Parameter | Non-anaemic patients (n = 490) | Anaemic patients (n = 61) | P |
|---|---|---|---|
| Age [years]* | 63.0 (53–72) | 71.0 (63–76) | 0.0006 |
| Sex: female/male | 142 (29%)/348 (71%) | 22 (36%)/39 (64%) | NS |
| Body mass [kg]* | 80 (70–88) | 70 (61–82) | 0.003 |
| BMI [kg/m$^2$]* | 27.6 (24.9–30.3) | 25.5 (22.2–31.3) | NS |
| History of MI | 56 (11%) | 10 (16%) | NS |
| History of PCI | 25 (5.0%) | 4 (6.5%) | NS |
| History of CABG | 9 (2%) | 0 | NS |
| History of stroke | 34 (7%) | 3 (5%) | NS |
| Hypertension | 250 (51%) | 38 (62%) | NS |
| Diabetes mellitus | 75 (15%) | 12 (20%) | NS |
| Smoking | 213 (43%) | 18 (30%) | NS |

*Median values with the lower and upper quartiles given in parentheses; BMI — body mass index; MI — myocardial infarction; PCI — percutaneous coronary intervention; CABG — coronary artery bypass grafting

**Table 2.** A comparison of the markers of clinical and haemodynamic status in patients with and without anaemia

| Parameter | Non-anaemic patients (n = 490) | Anaemic patients (n = 61) | P |
|---|---|---|---|
| Myocardial infarction location: | | | |
| Anterior | 197 (40%) | 27 (44%) | NS |
| Inferior | 274 (56%) | 30 (49%) | NS |
| Other | 17 (4%) | 4 (7%) | NS |
| Duration of chest pain before admission [min]* | 240 (180–360) | 240 (180–450) | NS |
| SBP on admission [mm Hg]* | 135 (120–150) | 125 (105–150) | 0.01 |
| DBP on admission [mm Hg]* | 80 (80–100) | 80 (70–90) | 0.02 |
| HR on admission [bpm]* | 75 (64–90) | 80 (67–100) | 0.04 |
| TIMI score (for STEMI)* | 3 (2–5) | 5 (3–7) | 0.00001 |
| Killip class* | 2 (2–2) | 2 (2–3) | < 0.002 |
| Ejection fraction [%]* | 48 (38–52) | 46 (38–50) | NS |
| Duration of hospitalisation at ICCU [days]* | 2 (2–3) | 3 (2–4) | 0.009 |

*Median values with the lower and upper quartiles given in parentheses; SBP — systolic blood pressure; DBP — diastolic blood pressure; HR — heart rate; TIMI — Thrombolysis In Myocardial Infarction; STEMI — ST-elevation myocardial infarction; ICCU — Intensive Coronary Care Unit

Compared to the non-anaemic patients, patients with anaemia were significantly older and had a lower body mass. We found no significant differences between the groups with regard to demographic and medical history parameters (Table 1). The groups did not differ in terms of infarct location, duration of chest pain or the EF on admission. The anaemic patients on admission had a significantly lower blood pressure, both systolic and diastolic, and a significantly higher heart rate. In terms of the baseline cardiac function they were in the higher Killip-Kimball class (Table 2). In order to assess and compare the risk in both groups we used the TIMI risk score for STEMI. The anaemic patients had significantly higher scores suggestive of a significantly higher risk for this group. This fact was indirectly reflected by the duration of hospitalisation at the ICCU, which was nearly one day longer in the case of the patients with anaemia.

Tables 3 and 4 compare the laboratory parameters between both groups. We observed a significant decrease in Hb in both groups during hospitalisation. We found no differences between the groups in CK-MB activity on admission or between peak values (Table 3). Baseline CRP was considerably elevated both in the anaemic and non-anaemic patients and was significantly higher in the anaemic group. In both groups the GFR suggested mild renal impairment (class I according to the Polish Nephrologic Society). In the anaemic patients, however, it was significantly lower than that in the patients without anaemia (Table 4). We found a positive correlation between Hb on admission and baseline GFR (r = 0.18,

**Table 3.** A comparison of haematologic parameters on admission and the lowest values during hospitalisation between the patients with and without anaemia

| Parameter | Non-anaemic patients (n = 490) | Anaemic patients (n = 61) | P |
|---|---|---|---|
| Hb on admission [g/dL] | 14.3 (13.6–15.2) | 11.9 (11.3–12.6) | 0.00001 |
| Lowest Hb value during hospitalisation [g/dL] | 13.3 (12.4–14.2) | 11.0 (10.3–12.1) | 0.00001 |
| WBC on admission [thousand/$\mu$L] | 11.4 (9.3–13.6) | 9.8 (8.6–11.4) | 0.0008 |
| Lowest WBC value during hospitalisation [thousand/$\mu$L] | 216.5 (182.0–266.5) | 208.0 (180.0–265.0) | NS |

Hb — haemoglobin; WBC — white blood count

**Table 4.** A comparison of myocardial injury markers, inflammation markers and renal function markers in patients with and without anaemia

| Parameter | Non-anaemic patients (n = 490) | Anaemic patients (n = 61) | P |
|---|---|---|---|
| CK-MB on admission [IU/L] | 37.0 (25.0–72.5) | 36.0 (23.0–74.0) | NS |
| Highest CK-MB value during hospitalisation [IU/L] | 185.0 (73.0–325.0) | 134.0 (65.0–271.0) | NS |
| C-reactive protein [mg/L] | 14.4 (8.0–32.6) | 24.8 (15.0–80.2) | 0.003 |
| GFR on admission [mL/min] | 75.8 (60.9–90.6) | 66.8 (44.7–79.2) | 0.008 |
| Lowest GFR value during hospitalisation [mL/min] | 80.9 (64.1–95.6) | 65.8 (38.4–83.9) | 0.0006 |

CK-MB — creatine kinase MB isoenzyme; GFR — glomerular filtration rate

**Table 5.** Risk factors for death or cardiovascular complications (univariate analysis)

| Factor | Odds ratio | 95% CI | P |
|---|---|---|---|
| Age | 1.03 | 1.01–1.05 | 0.0016 |
| SBP | 0.98 | 0.97–0.99 | 0.000001 |
| HR | 1.01 | 1.0–1.02 | 0.046 |
| Ejection fraction | 0.95 | 0.93–0.97 | 0.00001 |
| Duration of hospitalisation at the ICCU | 1.73 | 1.45–2.05 | 0.000001 |
| Hb on admission | 0.81 | 0.70–0.94 | 0.0046 |
| Lowest Hb | 0.76 | 0.66–0.88 | 0.0003 |
| GFR on admission | 0.99 | 0.98–1.00 | 0.0046 |
| Lowest GFR | 0.98 | 0.97–0.99 | 0.00001 |

CI — confidence interval; Hb — haemoglobin; GFR — glomerular filtration rate; rest abbreviations as in Table 2

**Table 6.** Risk factors for death or cardiovascular complications (multivariate logistic regression model)

| Factor | Odds ratio | 95% CI | P |
|---|---|---|---|
| Age | 1.03 | 1.01–1.05 | 0.003 |
| Systolic blood pressure | 0.98 | 0.976–0.992 | 0.0002 |
| Hb on admission | 0.89 | 0.754–1.051 | 0.17 |
| WBC on admission | 1.11 | 1.046–1.177 | 0.0006 |

CI — confidence interval; Hb — haemoglobin; WBC — white blood count

$p < 0.00001$) and the lowest GFR ($r = 0.2$, $p < 0.00001$). We also observed that GFR in the non-anaemic patients during hospitalisation significantly increased, while the change in the anaemic patients was non-significant.

We analysed deaths and in-hospital complications. A total of 8 (1.3%) patients died in the study (5 [8.2%] and 3 [0.6%] in the anaemic and non-anaemic groups, respectively, $p = 0.001$). The rate of CV complications was twice as high in the anaemic *vs* non-anaemic patients (33% *vs* 17%, $p = 0.003$). Uni- and multivariate analysis was used to evaluate the impact of the individual factors on mortality and CV complications (Tables 5, 6). In the univariate analysis (Table 5), the

mortality risk was associated with: age, systolic blood pressure and heart rate on admission, EF, duration of hospitalisation at the ICCU, Hb on admission and the lowest Hb during treatment, and GFR on admission and the lowest GFR during treatment. We developed a multivariate logistic regression model taking into account the following parameters: age, systolic blood pressure, Hb on admission and white blood count on admission. The odds ratios and the 95% confidence intervals for the individual parameters are summarised in Table 6. Haemoglobin level was not independently associated with the outcome.

## DISCUSSION

By reducing oxygen supply anaemia alone may cause myocardial ischaemia resulting in type 2 MI and may exacerbate pre-existing myocardial ischaemia and directly lead to ACS. The decreased supply of oxygen to the myocardium is compensated for by increased cardiac output and blood flow redistribution that protects the vital organs [10].

We analysed the significance of anaemia in patients with STEMI undergoing PCI using a large population of patients managed at a reference regional facility. In our opinion the most important finding was that even mild anaemia co-existing with MI and discovered on admission has an adverse prognostic significance. Patients with anaemia significantly differed from the remaining patients in terms of many parameters, both demographic, clinical and laboratory ones. Our findings are consistent with the majority of publications, although some investigators have not confirmed the adverse influence of reduced Hb on the outcomes in ACS [2, 4, 5, 8]. In contrast to some publications [11, 12], women did not predominate among the anaemic patients in our study. Some of our findings cannot be unequivocally explained, such as the lack of significant differences in the extent of left ventricular (LV) myocardial injury as assessed by LVEF and CK-MB levels. This may mean that the adverse influence of anaemia on the prognosis does not only depend on the extent of myocardial necrosis, but may also result from other unclear factors, such as chronic inflammation or co-morbidities.

The incidence of anaemia in ACS reported in the literature ranges from 12% to 30%, which may result from the selection of the study population [2, 4, 11]. In most publications all types of ACS were analysed. Perhaps the lower rate of anaemia in patients with STEMI results from the different pathomechanism of the infarction (vascular occlusion), other demographic and clinical features of the population of patients with STEMI compared to the entire group of patients with ACS [13–15]. Montalescot et al. [15] compared groups of patients with STEMI and NSTEMI. The STEMI patients were younger and predominantly male. They had less co-morbidities, such as type 2 diabetes mellitus, hypertension, peripheral artery disease. Importantly, there were significantly fewer patients with a history of HF in the STEMI *vs* NSTEMI groups (3.9% *vs* 8.9%) and this is the most likely reason for the higher rate of anaemia in patients with non-ST-elevation ACS.

The novelty of our study also rests in the analysis of the relationship between Hb levels and the TIMI risk score for STEMI. In patients with ACS, the usefulness of risk scores for predicting death and CV complications has been proved both in the short and long term [16, 17]. The score is calculated on the basis of the following factors: age, body mass, blood pressure and heart rate on admission and the Killip class. It was significantly higher in the population of anaemic patients.

Few reports on the significance of anaemia in patients with STEMI undergoing PCI have been published so far [18–20]. The most similar study in terms of demographic and clinical data to ours is the CADILLAC study [18]. A total of 2000 patients with acute MI were investigated (with STEMI accounting for 90% of the cases). The patients underwent primary PTCA within the first 12 hours after the onset of chest pain. Anaemia was found in 12.8% of the patients (11% in our study). The anaemic patients were characterised by higher in-hospital, 30--day and 1-year mortality rates. Anaemia was an independent risk factor for death. Aronson et al. [21] analysed a group of 1390 patients with acute MI (STEMI and NSTEMI) in terms of the prognostic significance of anaemia. Anaemia was identified in 17.8% of the patients on admission in and as many as 36.0% at discharge. The lowest Hb was, on average, 1.3 g/dL lower than the baseline values. This trend was also observed in our patients, irrespective of their baseline Hb values. The most likely cause is the blood loss during PCI, especially through the femoral approach, the aggressive anticoagulant and antiplatelet treatment and the haemodilution caused by the administration of intravenous fluids during the first days post-infarction. The highest prognostic value (higher than anaemia on admission) had the Hb reduction (a decrease of 1 g/dL in Hb concentration increased mortality by a factor of 1.36).

In our study population we confirmed the relationship between anaemia and renal failure. When we compared the anaemic with non-anaemic patients we found the known relationship between anaemia and renal failure, also present in STEMI patients. In a STEMI population similar to ours it was found that a reduction in Hb levels of 1 g/dL below 15 g/dL and in creatinine clearance of 10 mL/min was associated with an increasing mortality risk [12]. As demonstrated by Kruk et al. [20] in patients with STEMI undergoing primary PCI the triad of anaemia, hyperglycaemia and elevated serum creatinine most adversely affected the outcomes.

Therefore, are the populations of patients with HF and ACS with co-existent anaemia similar? Or perhaps the adverse prognosis in the group of patients with ACS is partially caused by the co-existent HF? No such comparison has so far been conducted. Based on the reviewed literature on the relationship between anaemia and HF and based on the comparison with our material it seems that anaemia is more prevalent in patients with HF than in patients with ACS (up to

61%) [22]. In both groups we observed a similar increase in the anaemia rate with age, a relationship with chronic kidney disease and a poorer prognosis. Due to the retrospective nature of the study we could not establish whether and what percentage of our patients were carrying the diagnosis of HF when the infarction was diagnosed. We may only assume, analysing the co-morbidities, that the proportion of patients with systolic HF could not have been large (only 12% had a history of MI). More than a half of the patients had a history of primary hypertension, which could be associated with previously undiagnosed HF with preserved EF. The studies conducted in the recent years confirm the relationship between this form of HF and anaemia both in terms of co-existence and poor prognosis [23].

It is still unclear whether anaemia is merely a marker of inflammation or a poor prognostic factor (in the former case its treatment will not result in any improvement, while in the latter case treatment will matter) [24]. The effect of erythropoietin on LV remodelling in acute MI has recently become a topic of extensive research. The results of the HEBE III study presented at the 2010 ESC Congress have not confirmed any beneficial effect of erythropoietin on cardiac function in acute MI [25].

## CONCLUSIONS

1. The presence of anaemia, even mild anaemia, adversely affected the outcomes. It was manifested by a poorer haemodynamic status and was associated with a higher risk of death and CV complications during the in-hospital period.
2. The adverse impact of anaemia on prognosis in patients with STEMI undergoing PCI is complex and cannot be solely explained by the mechanism of increased post-infarction myocardial injury.

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# Znaczenie niedokrwistości u chorych z ostrym zawałem serca z uniesieniem odcinka ST leczonych pierwotną angioplastyką wieńcową

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## Streszczenie

**Wstęp:** Wpływ współistniejącej niedokrwistości na występowanie i przebieg ostrych zespołów wieńcowych jest od niedawna intensywnie badany. Dane na temat znaczenia niedokrwistości u pacjentów z zawałem serca z uniesieniem odcinka ST (STEMI) leczonych interwencyjnie są mniej liczne, a wnioski niejednoznaczne.

**Cel:** Celem pracy była ocena częstości występowania i wpływu niedokrwistości na wczesne rokowanie u chorych leczonych interwencyjnie z powodu STEMI.

**Metody:** Na podstawie retrospektywnej analizy dokumentacji hospitalizowanych chorych wyselekcjonowano grupę badaną, którą stanowiło 551 kolejnych osób ze STEMI, w tym 164 kobiety (śr. wieku 63,4 ± 12 lat), poddanych pierwotnej interwencji wieńcowej (PCI) w ciągu 12 godzin od początku bólu zawałowego. Niedokrwistość oceniano na podstawie morfologii krwi przy przyjęciu wg definicji Światowej Organizacji Zdrowia (< 12 g/dL u kobiet i < 13 g/dL u mężczyzn).

**Wyniki:** U 61 (11%) badanych stwierdzono niedokrwistość (13% u kobiet, 10% u mężczyzn). Pacjenci z niedokrwistością byli starsi (71 *v.* 63 lat; $p < 0,001$), mieli niższą masę ciała (70 *v.* 80 kg; $p < 0,003$), byli bardziej obciążeni wg skali ryzyka TIMI dla STEMI (5 *v.* 3; $p < 0,0001$). W badaniach laboratoryjnych stwierdzono u nich bardziej upośledzoną funkcję nerek (GFR 66,8 *v.* 75,8 ml/min; $p < 0,008$) i wyższe stężenie białka C-reaktywnego (24,8 *v.* 14,4 mg/l; $p< 0,001$). Nie zaobserwowano istotnej różnicy w stopniu pozawałowego uszkodzenia serca ocenianego na podstawie frakcji wyrzutowej oraz aktywności wyjściowego i maksymalnego CK-MB. W trakcie leczenia w obu grupach zanotowano istotny spadek stężenia hemoglobiny — z 11,9 do 11 g/dl u pacjentów z niedokrwistością ($p < 0,0004$) oraz z 14,3 do 13,3 g/dl u pozostałych osób ($p < 0,001$). Wartość GFR nie zmieniała się istotnie u chorych z niedokrwistością, podczas gdy u pozostałych znamiennie wzrosła — z 75,8 do 80,9 ml/min ($p < 0,001$). Śmiertelność wewnątrzszpitalna była niska, zmarło 8 (1,3%) chorych, 5 (8,2%) wśród pacjentów z niedokrwistością i 3 (0,6%) spośród pozostałych osób. Różnica ta była bardzo znamienna statystycznie ($p < 0,001$). W grupie z niedokrwistością częściej występowały również powikłania sercowo-naczyniowe (33% *v.* 17%; $p = 0,003$). W analizie wieloczynnikowej starszy wiek, skurczowe ciśnienie tętnicze przy przyjęciu i leukocytoza wiązały się ze zwiększonym ryzykiem zgonu oraz powikłań sercowo-naczyniowych, podczas gdy wyjściowe stężenie hemoglobiny było istotnym statystycznie parametrem tylko w analizie jednoczynnikowej.

**Wnioski:** Chorzy z niedokrwistością, u których dochodzi do STEMI, stanowią od chwili przyjęcia do szpitala odrębną, bardziej obciążoną populację, z wyraźnie większym ryzykiem zgonów i wewnątrzszpitalnych powikłań kardiologicznych. Niekorzystny wpływ niedokrwistości na rokowanie u chorych z ostrym zawałem serca leczonych inwazyjnie ma charakter złożony i nie może być wyjaśniony jedynie poprzez mechanizm większego zawałowego uszkodzenia serca. U chorych ze STEMI niedokrwistość przy przyjęciu powinna być traktowana jako dodatkowy czynnik ryzyka.

**Słowa kluczowe:** niedokrwistość, zawał serca z uniesieniem odcinka ST, pierwotna interwencja wieńcowa

Kardiol Pol 2011; 69, 1: 33–39

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**Praca wpłynęła:** 30.08.2010 r. **Zaakceptowana do druku:** 20.10.2010 r.