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Survival benefit from recent changes in management of men and women with ST-segment elevation myocardial infarction treated with percutaneous coronary interventions

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Abstract

Background: *Nowadays, the majority of patients with myocardial infarction with ST-segment elevation (STEMI) are treated with primary percutaneous coronary interventions (PCI). In recent years, there have been ongoing improvements in PCI techniques, devices and concomitant pharmacotherapy. However, reports on further mortality reduction among PCI-treated STEMI patients remain inconclusive. The aim of this study was to compare changes in management and mortality in PCI-treated STEMI patients between 2005 and 2011 in a real-life setting.*

Methods: *Data on 79,522 PCI-treated patients with STEMI from Polish Registry of Acute Coronary Syndromes (PL-ACS) admitted to Polish hospitals between 2005 and 2011 were analyzed. First, temporal trends of in-hospital management in men and women were presented. In the next step, patients from 2005 and 2011 were nearest neighbor matched on their propensity scores to compare in-hospital, 30-day and 1-year mortality rates and in-hospital management strategies and complications.*

Results: *Some significant changes were noted in hospital management including shortening of median times from admission to PCI, increased use of drug-eluting stents, potent antiplatelet agents but also less frequent use of statin, beta-blockers and angiotensin converting enzyme inhibitors and angiotensin II receptor blockers. There was a strong tendency toward preforming additional PCI of non-infarct related arteries, especially in women. After propensity score adjustment there were significant changes in in-hospital but not in 30-day or 1-year mortality rates between 2005 and 2011. The results were similar in men and women.*

Conclusions: *There were apparent changes in management and significant in-hospital mortality reductions in PCI-treated STEMI patients between 2005 and 2011. However, it did not result in 30-day or 1-year survival benefit at a population level. There may be room for improvement in the use of guideline-recommended pharmacotherapy.* (Cardiol J 2019; 26, 5: 459–468)

Key words: ST-segment elevation myocardial infarction, percutaneous coronary intervention, temporal trends, treatment strategy, in-hospital mortality, 1-year mortality, sex-differences

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Introduction

Most of recent studies have confirmed a significant reduction in mortality rates among patients with myocardial infarction with ST-segment elevation (STEMI) during the last 10–20 years [1–3]. The increased use of percutaneous coronary interventions (PCI) has unquestionably been key improvement in STEMI treatment. Nevertheless, there are other important changes evolving in PCI techniques and new evidence-based concomitant pharmacotherapy. Recent advances in angioplasty devices, including manual aspiration catheters and drug-eluting stents (DES), potent antiplatelet and anticoagulant agents, have significantly enhanced outcomes for STEMI patients [4], not to mention shorter door-to-balloon (D2B) times, growing experience of operators performing PCI and efforts put into implementation of evidence-based treatments into real-life clinical practice. However, the scope and reasons for the observed decline in mortality remain inconclusive, especially among PCI-treated patients and in sex-specific analyses.

A large study from Northern Italy presented a weak temporal trend in mortality reduction from 2000 to 2010 in men only, despite increases in the use of an invasive approach in both sexes [5]. In contrast, an American study including patients with STEMI who underwent primary PCI from 2003 to 2008 reported a tendency toward decreased in-hospital mortality only among women but even that was not statistically significant [6]. Some newer studies including mostly patients treated with PCI showed that there was no further improvement regarding in-hospital [7], 30-day [8] or 1-year mortality despite changes in patient characteristics and concomitant treatment [9]. On the other hand, French data demonstrated a decrease in 30-day mortality rates also among patients treated with PCI from 1995 to 2010 [10]. Similarly, British investigators found that 6-month survival improved significantly from 2003 to 2010 for STEMI patients who received reperfusion therapy [11].

Clinical profiles of STEMI patients have been changing over time and it has already been demonstrated in the Polish population [12]. Female STEMI patients differ significantly from males [13] and may undergo independent temporal changes in terms of clinical characteristics and modes of treatment [12, 14], which warrants separate analyses of both sexes. It was reported that women are less likely to undergo proper reperfusion treatment [1, 3, 15] and to receive early drug therapies even after adjustment for baseline characteristics [1]. Recently published registry data have also shown that, despite advances in care, women continue to experience higher mortality rates compared with men in STEMI [16] or after PCI for coronary artery disease [17].

The aims of this study are to compare changes and analyze temporal trends in hospital management of men and women with STEMI treated with PCI from 2005 to 2011 and determine if it resulted in better in-hospital, 30-day and 1-year survival rates.

Methods

The Polish Registry of Acute Coronary Syndromes (PL-ACS) is an ongoing, nationwide, multicenter, prospective, observational study of patients hospitalized with acute coronary syndromes (ACS). The registry is a joint initiative of the Silesian Center for Heart Diseases and the Polish Ministry of Health. Patients admitted with suspected ACS were screened for their eligibility to enter the registry, but they were not enrolled until ACS was confirmed. During the study period, 449 hospitals participated in the registry, 132 of them with PCI facilities and 20 with onsite cardiac surgery. The registry covered around 70% of all hospitals where STEMI patients were treated in Poland including primary, secondary and tertiary-level hospitals as well as academic and university centers.

In the current study all patients enrolled in the PL-ACS Registry hospitalized between 2005 and 2011 with the diagnosis of STEMI were evaluated (111,148). Of them, 79,522 (71.5%) were treated with PCI and were included in further analyses (25,155 women and 54,367 men). STEMI was defined as the presence of ST-segment elevation of ≥ 2 mm in the contiguous chest leads and/or ST-segment elevation of ≥ 1 mm in two or more standard leads or a new left bundle branch block, together with positive cardiac necrosis markers (cardiac troponin or creatine kinase-MB). For the patients who presented more than once during the study period only the first hospitalization was analyzed. All-cause mortality data were obtained from the official mortality records of the National Health Fund. The vital statuses at discharge, 30-day and 1-year were available for all patients included. The study adhered to the Declaration of Helsinki and its revision from 2008 and was approved by the Bioethics Committee at the Swietokrzyska Chamber of Physicians.

Temporal trends for in-hospital PCI-related treatment strategies were presented (D2B times,

PCI type, Thrombolysis in Myocardial Infarction [TIMI] flow 3 after PCI, additional PCI of any non-infarct-related artery (IRA) during index hospitalization). Continuous variables were presented as means ± standard deviation or median ± interquartile range, depending on the normality of the distribution. Categorical variables were presented as counts and percentages. The significance of the time trends was tested with Jonckheere-Terpstra test for continuous variables and Cochran-Armitage test for categorical variables.

To adjust data from 2005 and 2011 available baseline characteristics of PCI-treated patients (Table 1) were incorporated into a regression model to estimate a propensity score (PS) of each individual. In the next step, the patients from 2011 were nearest neighbor matched on their PS to patients from 2005. A total of 15,886 individuals were successfully matched within a pre-defined PS distance. Women and men were analyzed separately. Standardized differences were calculated for assessing balance in baseline characteristics between subjects from 2005 and 2011 (Table 1). The overlap and the region of common support between the groups were checked by visual analysis. In-hospital treatment strategies including pharmacotherapy, in-hospital complications (myocardial reinfarction, ischemic stroke and major bleeding) as well as in-hospital, 30-day and 1-year mortality rates were compared between patients from 2005 and 2011. Significance of differences between the study groups was assessed by the Student t-test or Mann-Whitney U test for continuous variables and χ^2 test for categorical variables. A two-sided p value ≤ 0.05 was considered significant.

The calculations and statistical analyses were performed with STATISTICA 10 (StatSoft Inc., Tulsa, OK, USA), MedCalc (MedCalc Software, Belgium) and SPSS 17.0 (SPSS Inc., Chicago, IL, USA).

Results

The fraction of patients treated with PCI was increasing annually from 53.3% in 2005 to 93.8% in 2011. A majority of patients included in the analysis were treated with primary PCI. Small and declining percentages of all PCI-treated patients had PCI after thrombolysis or PCI followed by emergent coronary artery bypass grafting during index hospitalization. Detailed unadjusted trends are presented in Tables 2 and 3. TIMI flow after PCI was reported in 99% of patients.

When comparing crude data men were more often treated with PCI and more often had TIMI 3 flow after PCI than women — both in 2005 and 2011 ($p < 0.001$). Bare metal stents (BMS) were more often implanted in men in 2005 ($p = 0.001$) but not in 2011 ($p = 0.53$) whereas DES were more often implanted in men in 2011 ($p = 0.003$) but not in 2005 ($p = 0.07$). Women more frequently had at least one additional PCI of non-IRA in 2011 ($p < 0.001$) but not in 2005 ($p = 0.55$). There was a strong trend (1.6% average absolute change per year) towards increased fractions of women undergoing additional PCI of non-IRA whereas a corresponding trend in male patients was only 0.3% per year. The differences in D2B times were not statistically significant between sexes ($p = 0.32$ in 2005 and $p = 0.1$ in 2011). However, the 1–2 min longer D2B times in women were reported relatively constantly throughout the study period.

Following adjustment of 2005 and 2011 populations with PS matching technique many notable differences were observed in treatment strategies including in-hospital pharmacotherapy (Tables 4 and 5).

A substantial increase in additional PCI of non-IRA, particularly in women, was also confirmed in PS-matched subgroups; thus, it proved to be likely unrelated to temporal changes in initial characteristics. There was an increase in hospital colpidogrel and glycoprotein IIb/IIIa inhibitors usage in both sexes. At the same time there was a decrease in acetylsalicylic acid (ASA), beta-blockers, statins and angiotensin converting enzyme inhibitors (ACEI) or angiotensin II receptor blockers (ARBs) usage in both sexes. The percentage of patients who received ASA at discharge increased in 2011 when compare to in-hospital usage and was not significantly different from the percentage observed in 2005. At the same time some patients who were given in-hospital clopidogrel were discharged without this drug. In-hospital complications were rare; there was a further decline in the number of myocardial reinfarctions and ischemic strokes (only in women) and non-statistically significant increase in major bleeding was reported during hospitalization. In-hospital mortality rates of STEMI patients decreased between 2005 and 2011 in both sexes. However, there was no significant change in 30-day or 1-year mortality rates in neither men nor women (Tables 4 and 5).

Discussion

The main finding of this study is that, despite numerous advances in hospital management and in-hospital mortality reduction, no significant decrease in 30-day or 1-year mortality was observed. In fact, the first 30 days was critical in terms of STEMI patients

Table 1. Clinical characteristics on admission after propensity score matching.

	Women (n = 5253)			Men (n = 10633)		
	2005 N = 2615	2011 N = 2638	S. Diff.	2005 N = 5328	2011 N = 5305	S. Diff.
Age	67.1 ± 11.1	67.5 ± 12.2	**0.05**	60.5 ± 11.2	60.8 ± 11.2	**0.04**
Hypertension	68.9%	66.5%	**–0.05**	58.7%	59.9%	**0.02**
Diabetes	28.6%	25.7%	**–0.07**	16.7%	17.5%	**0.02**
Hypercholesterolemia	43.7%	42.9%	**–0.02**	40.4%	40.8%	**0.01**
Current smoking	31.8%	30.7%	**–0.02**	60.7%	61.7%	**0.02**
Obesity	24.9%	22.8%	**–0.05**	13.9%	15.1%	**0.03**
Prior MI	7.8%	7.9%	**0.00**	9.7%	9.3%	**–0.01**
Prior PCI	1.4%	1.4%	**0.00**	2.2%	2%	**–0.01**
Prior CABG	1%	1%	**0.00**	1.8%	1.7%	**–0.01**
Systolic BP on admission [mmHg]:						
< 100	8.1%	9.3%	**0.04**	7.4%	7%	**–0.02**
100–160	73.6%	72.7%	**–0.02**	75.8%	75.3%	**–0.01**
> 160	18.3%	18%	**–0.01**	16.8%	17.7%	**0.02**
ECG on admission (rhythm):						
Sinus rhythm	92.2%	91.2%	**–0.04**	93.6%	93.9%	**0.01**
Atrial fibrillation	5.8%	5.8%	**0.00**	4%	4%	**0.00**
Pacing	0.2%	0.3%	**0.02**	0.2%	0.2%	**0.00**
Other	1.8%	1.9%	**0.01**	2.2%	1.9%	**–0.02**
HR > 100/min	7.7%	7.8%	**0.00**	6.6%	6.5%	**0.00**
ECG on admission (intraventricular conduction):						
Normal	89.1%	88.9%	**–0.01**	88.6%	88.8%	**0.01**
LBBB	1.8%	1.9%	**0.01**	1.5%	1.4%	**–0.01**
RBBB	2.6%	2.6%	**0.00**	3.5%	3.2%	**–0.02**
Other	6.5%	6.6%	**0.00**	6.5%	6.5%	**0.00**
Infarct location:						
Anterior	39.8%	41.1%	**0.03**	40.2%	40%	**0.00**
Inferior	50.3%	50.2%	**0.00**	51.5%	51.3%	**0.00**
Other	9.9%	8.8%	**–0.04**	8.3%	8.7%	**0.01**
Time from symptom-onset to admission [h]:						
0–2	21.5%	21.7%	**0.00**	25.8%	25.5%	**–0.01**
2–12	63.5%	61.6%	**–0.04**	58.8%	60.1%	**0.03**
> 12	15%	16.7%	**0.05**	15.3%	14.4%	**–0.03**
Prehospital cardiac arrest	2%	2.3%	**0.02**	3.3%	2.8%	**–0.03**
Killip class on admission:						
IV	6.2%	5.8%	**–0.02**	4.7%	4.7%	**0.00**
III	2.1%	1.9%	**–0.01**	1.7%	1.5%	**–0.02**
II	10.7%	10.1%	**–0.02**	9.4%	9.9%	**0.02**
I	81%	82.2%	**0.03**	84.2%	83.8%	**–0.01**
LVEF [%]:						
> 50%	49%	47.1%	**–0.04**	48.7%	49.1%	**0.01**
30–50%	46%	47.8%	**0.04**	46.6%	46%	**–0.01**
< 30%	5%	5.2%	0.01	4.7%	4.8%	**0.00**

BP — blood pressure; CABG — coronary artery bypass grafting; ECG — electrocardiogram; HR — heart rate; LBBB — left bundle branch block; LVEF — left ventricular ejection fraction; MI — myocardial infarction; PCI — percutaneous coronary intervention; RBBB — right bundle branch block; S. Diff. — standardized difference

Table 2. Trends in management of percutaneous coronary intervention (PCI)-treated women with ST-segment elevation myocardial infarction (STEMI) from 2005 to 2011.

Year (n = number of women with STEMI)	2005 N = 6422	2006 N = 6790	2007 N = 5434	2008 N = 4396	2009 N = 4365	2010 N = 5206	2011 N = 5047	P for trend	Average absolute change per year
Treated with PCI	3052 (47.5%)	3374 (49.7%)	3138 (57.7%)	2900 (66.0%)	3443 (78.9%)	4605 (88.5%)	4643 (92.0%)	< 0.001	
With thrombolysis	36	38	9	6	15	14	12	< 0.001	
With CABG	34	23	13	19	0	2	0	< 0.001	
Door to balloon time [min]	46 (30–75)	45 (30–71)	45 (30–73)	45 (29–75)	41 (29–65)	44 (30–70)	43 (30–65)	< 0.001	–0.54 min
Additional PCI of non-IRA	8.6%	8.0%	8.7%	11.5%	11.4%	15.0%	17.9%	< 0.001	1.6%
PCI type:									
Balloon angioplasty	9.9%	8.1%	8.5%	7.9%	7.4%	6.5%	7.4%	< 0.001	–0.4%
Bare metal stent	89.1%	90.2%	89.6%	90.0%	88.4%	85.0%	76.4%	< 0.001	–1.8%
Drug eluting stent	1.1%	1.7%	1.9%	2.1%	4.2%	8.4%	16.2%	< 0.001	2.2%
TIMI 3 flow after PCI	88.9%	89.6%	88.4%	89.7%	90.3%	90.0%	89.9%	0.069	NS

CABG — coronary artery bypass grafting; non-IRA — non-infarct related artery; TIMI — Thrombolysis in Myocardial Infarction

Table 3. Trends in management of percutaneous coronary intervention (PCI)-treated men with ST-segment elevation myocardial infarction (STEMI) from 2005 to 2011.

Year (n = number of men with STEMI)	2005 N = 12180	2006 N = 13083	2007 N = 11020	2008 N = 8355	2009 N = 8775	2010 N = 10934	2011 N = 9141	P for trend	Average absolute change per year
Treated with PCI	6866 (56.4%)	7715 (59.0%)	7363 (66.8%)	6129 (73.4%)	7601 (86.6%)	10028 (91.7%)	8665 (94.8%)	< 0.001	
With thrombolysis	104	73	45	29	31	28	10	< 0.001	
With CABG	66	61	22	24	4	2	2	< 0.001	
Door to balloon time [min]	45 (30–72)	44 (29–69)	43 (29–69)	44 (29–70)	40 (28–65)	42 (30–65)	42 (30–63)	< 0.001	–0.6 min
Additional PCI of non-IRA	8.9%	7.7%	8.5%	11.1%	10.6%	9.9%	9.9%	< 0.001	0.3%
PCI type:									
Balloon angioplasty	8.20%	7.30%	6.30%	6.50%	6.30%	6.30%	5.90%	< 0.001	–0.3%
Bare metal stent	91.10%	90.70%	91.50%	91.40%	89.50%	83.70%	75.90%	< 0.001	–2.2%
Drug eluting stent	0.70%	2%	2.20%	2%	4.20%	10%	18.30%	< 0.001	2.5%
TIMI 3 flow after PCI	91.1%	91.4%	91.3%	92.2%	91.6%	91.8%	92.2%	0.032	0.2%

CABG — coronary artery bypass grafting; non-IRA — non-infarct related artery; TIMI — Thrombolysis in Myocardial Infarction

Table 4. Changes in management and 30-day mortality of percutaneous coronary intervention (PCI)--treated women with ST-segment elevation myocardial infarction from 2005 and 2011 matched on propensity scores.

	2005	2011	P
Door to balloon time [min]	47 (30–75)	43 (30–65)	< 0.001
Additional PCI of non-IRA	8.6%	18.4%	< 0.001
PCI type:	9.6%	7.1%	< 0.001
Balloon angioplasty			
Bare metal stent	89.3%	76.3%	< 0.001
Drug eluting stent	1.1%	16.6%	< 0.001
TIMI 3 flow after PCI	88.8%	90.6%	0.032
In-hospital pharmacotherapy:	96.0%	89.2%	< 0.001
ASA			
Clopidogrel	77.4%	98.9%	< 0.001
GP IIb/IIIa inhibitors	24.6%	31.1%	< 0.001
Beta-blockers	79.3%	70.1%	< 0.001
Statins	84.3%	75.4%	< 0.001
ACEIs or ARBs	77.1%	64.6%	< 0.001
In-hospital complications:	3.1%	0.2%	< 0.001
Myocardial reinfarction			
Ischemic stroke	0.8%	0.3%	0.005
Major bleeding	1.3%	1.7%	0.23
Pharmacotherapy at discharge:			
ASA	95.9%	95.9%	0.93
Clopidogrel	41.4%	92.5%	< 0.001
In-hospital mortality	7.5%	5.7%	0.011
30-day mortality	9.1%	8.9%	0.84
1-year mortality	14.5%	13.9%	0.5

ACEIs — angiotensin converting enzyme inhibitors; ASA — acetylsalicylic acid; ARBs — angiotensin II receptor blockers; GP IIb/IIa — glycoprotein IIb/IIIa; non-IRA — non-infarct related artery; TIMI — Thrombolysis in Myocardial Infarction

prognosis as patients who survive the first month after STEMI treated with primary PCI have only a < 1.5% annual risk of successive cardiac death [18]. There have been major improvements in the delivery of care for STEMI patients including the increased use of PCI and adjunctive therapies, but at the same time some unexpected tendencies in guideline-recommended pharmacotherapy were noted.

Significant reductions were observed of-in hospital D2B delays which is consistent with observations of other authors [19, 20]. Only patients who had PCI performed within 12 h from symptom onset were analyzed, thus the present results have shorter D2B times than most other studies. The medians of D2B times shortened slightly but significantly between 2005 and 2011 — compromising the right direction of changes in management. Women continue to have longer D2B times but the average difference between sexes was only around 1–2 min. It was not statistically significant but remained relatively constant throughout the study period. A study of STEMI patients in Australia analyzing D2B time components have confirmed longer delays in both diagnosis and instituting PCI therapy in women [21]. A potential factor that may contribute to the delay may be related to anatomic factors including smaller diameter of coronary vessels in women [22] and potential technical difficulties in performing the PCI. Possibly for the same reason optimal — TIMI 3 flow after PCI was more often achieved in men during the study period and no significant trend toward reduction of this particular sex discrepancy was noted.

Drug eluting stent compared with BMS are not associated with morality reduction but they improve clinical outcomes by reducing the risk of reintervention [23]. DES is currently preferred over BMS in STEMI patients without contrain-

Table 5. Changes in management and 30-day mortality of percutaneous coronary intervention (PCI)--treated men with ST-segment elevation myocardial infarction from 2005 and 2011 matched on propensity scores.

	2005	2011	P
Door to balloon time [min]	46 (30–72)	41 (30–62)	< 0.001
Additional PCI of non-IRA	8.6%	9.8%	0.032
PCI type:			
Balloon angioplasty	7.8%	5.1%	< 0.001
Bare metal stent	91.6%	75.8%	< 0.001
Drug eluting stent	0.6%	19%	< 0.001
TIMI 3 flow after PCI	91.1%	92.5%	0.013
In-hospital pharmacotherapy:			
ASA	96.3%	90.6%	< 0.001
Clopidogrel	78.3%	98.8%	< 0.001
GP IIb/IIIa inhibitors	28.1%	35.6%	< 0.001
Beta-blockers	81.3%	75.9%	< 0.001
Statins	87.0%	81.3%	< 0.001
ACEIs or ARBs	78.5%	69.8%	< 0.001
In-hospital complications:			
Myocardial reinfarction	2.9%	0.3%	< 0.001
Ischemic stroke	0.2%	0.2%	0.69
Major bleeding	0.6%	0.8%	0.079
Pharmacotherapy at discharge:			
ASA	96.8%	96.5%	0.46
Clopidogrel	43%	93,1%	< 0.001
In-hospital mortality	4.1%	3.3%	0.034
30-day mortality	5.4%	5.5%	0.86
1-year mortality	9.5%	9.7%	0.73

ACEIs — angiotensin converting enzyme inhibitors; ASA — acetylsalicylic acid; ARBs — angiotensin II receptor blockers; GP IIb/IIa — glycoprotein IIb/IIIa; non-IRA — non-infarct related artery; TIMI — Thrombolysis in Myocardial Infarction

dications to prolonged dual antiplatelet therapy [24]. It was observed that women are less likely to receive DES. The potential gender-related differences in stent type selection might be related to a physician's notion of an increased risk of bleeding in women on prolonged dual antiplatelet therapy, their statistically greater age or other non-specific sex-related disparities. However, the frequency of use of DES has been significantly increasing for both sexes presumably due to better availability and an increasingly established role of DES as a standard mode of treatment in ACS.

In patients with STEMI undergoing infarct-artery PCI benefits of PCI in non-infarct coronary arteries with major stenoses is a subject of debate. European Society of Cardiology (ESC) Guidelines present during the study period did not clearly refer to treating non-infarct related vessels, apart from suggesting treatment of the infarct-related lesion by PCI and perform coronary artery bypass grafting later under more stable conditions. Later, in 2012 ESC Guidelines stated that primary PCI should be limited to the culprit vessel with the exception of cardiogenic shock and persistent ischemia after PCI of the supposed culprit lesion [24]. However, recent CULPRIT-SHOCK trial showed that additional intervention on non infarct-related lesions in cardiogenic shock was associated with higher 30-day risk of unfavorable outcomes [25]. The 2013 American College of Cardiology Foundation/American Heart Association (ACCF/AHA) Guidelines designated a Class III recommendation for multivessel primary PCI in hemodynamically stable patients with STEMI; it has recently been modified to a Class IIb in the 2015 Update [26]. Recently published results of PRAMI [27], CvLPRIT [28] and DANAMI-3 PRIMULTI [29] trials showed that complete revascularization during the

index admission in patients with STEMI and multivessel disease may be of benefit. Those results have already been incorporated into the current 2017 ESC STEMI Guidelines [30]. An unexpected finding is that the percentage of women undergoing additional PCI of at least one non-IRA almost doubled during the study period whereas a corresponding trend in male patients was over 5 times weaker. Although, in general, women tend to have a more diffused disease, it most probably could not fully explain such a strong trend. Despite a lack of recommendations for routine preventive PCI in STEMI patients, it had been performed in women surprisingly often and only forthcoming trials were to confirm that this is a safe and potentially beneficial approach. It is interesting and warrants further studies of other potential underlying causes.

The frequencies of the use of novel antiplatelet agents (clopidogrel and glycoprotein IIb/IIIa inhibitors) have increased. This is not surprising with regard to the importance of platelet inhibition in PCI-treated patients. In contrast, at the same time the use of ASA and other evidence based medicine-based medications have decreased. Single authors reported similar tendencies in ASA usage in secondary prevention and hypothesized that it may be attributable to a rise in novel antiplatelet agent usage, and physicians being less insistent on dual antiplatelet therapy in patients with a minor intolerance to ASA [11]. However, in the present study the percentages of patients who were recommended ASA at discharge were comparable between 2005 and 2011. On the other hand, some patients who received in-hospital clopidogrel were discharged without this drug, especially in 2005, which might be related to possible economic issues and the use of another thienopyridine (ticlopidine) instead. There may also have been a small number of patients who had STEMI in the mechanism other than atherosclerosis and there was a decision not to prolong aggressive antiplatelet therapy. Significant decreases in the use of beta-adrenolytic agents, ACEI or ARBs and statins was unexpected. Early ACE inhibition was shown to reduce mortality as early as 30 days after STEMI, with most of the benefit observed during the first week [31]. Statins lower both short and long-term mortality in MI patients and is most beneficial when treatment is initiated which was observed early after admission to the hospital [32]. On the other hand, the administration of early beta-blocker therapy in acute MI has failed to prove a net benefit on mortality [33], despite well-established benefits in longer observations. It has gradually been realized that the greatest benefit of using beta-blockers and ACEI is expected in selected groups of patients (i.e. those with heart failure or left ventricular dysfunction) and our observations may reflect a tendency toward a more discriminating usage of those drugs. Nevertheless, there is no data to confirm this hypothesis as this observation may be related to lower quality of care as well. Especially taking into account that 2012 and 2017 ESC Guidelines presented high IIA Class of recommendation for the routine beta-blocker and ACEI use in all patients without contraindications [24, 30]. A significant decrease in statin use in the present study is alarming and presents an unclear tendency. Optimal medical therapy could be as important as reperfusion therapy in the PCI era [34]. Some pitfalls in this field could explain why no further mortality reduction was observed despite substantial changes in STEMI management. A similar analysis (data not published yet) that included all patients, regardless of treatment strategy, showed better pharmacotherapy standards. This may reflect an improper tendency to pay less attention to concomitant pharmacotherapy in patients who have undergone PCI reperfusion.

In-hospital complication rates considerably declined, which undoubtedly helped to achieve better in-hospital survival rates. Myocardial reinfarctions became less frequent in both sexes. Ischemic strokes were already rare in 2005 in men and their rates significantly decreased in women. The rates of major bleeding during hospitalization showed an insignificant rise in both sexes. This effect was most likely due to an increased use of antiplatelet (and possibly also antithrombotic) agents. However, taking into account significant declines in rates of reinfarctions and ischemic strokes, no significant increase in major bleedings suggest an acceptable safety profile of new management approaches.

There are wide differences in reported mortality rates of STEMI patients and treatment-related statistics across countries [6, 8, 11]. However, in this study mostly data in propensity score matched cohorts allowed for comparing changes between 2005 and 2011 were presented but may not reflect actual frequencies observed in the whole population, so comparisons with other studies are not applicable. The focus herein was mainly on the survival benefit from ongoing changes in treatment among PCI-treated patients and, as mentioned

before, data from other studies which have shown inconsistent results [6–10]. It was believed that each region should be analyzed separately to explore potential factors contributing to variations in outcomes of STEMI patients in the PCI-era.

Limitations of the study

A number of possible limitations of this study should be mentioned. First, it is retrospective in nature using registry data. Participation in PL-ACS Registry is voluntary and participating sites varied during the study period so selection bias cannot be excluded. Some initial patient characteristics were not available (for example data on renal failure or anemia) which might have affected PS model quality. Also some information on treatment strategy (for example data on thrombus aspiration or catheterization access — radial vs. femoral) and data on post-discharge treatment, including pharmacotherapy and the length of dual antiplatelet therapy, were not available. Unavailable records of post-discharge management (compliance to prescribed pharmacotherapy, rehabilitation or the rates of cardioverter-defibrillator implantations) could also be considered important predictors of medium and long-term mortality.

Conclusions

Many changes in PCI techniques and concomitant management in patients with STEMI treated with PCI between 2005 and 2011 in Poland and a significant reduction of their in-hospital mortality rates were noted. However, no significant reduction in 30-day or 1-year mortality was observed. These results have been analogous in male and female populations. The observed trends in treatment strategies have generally presented ongoing improvement which followed current guidelines. There remains room for further improvement in the field of concomitant in-hospital pharmacotherapy among PCI-treated patients. Although randomized control trials have confirmed efficiency of particular interventions, their overall association with medium and long-term mortality reduction at the population level was not confirmed in this study. It could be related to implementation rates of new treatments in a real-life setting and should not be interpreted as calling into question their individual-level of usefulness.

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