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All-cause readmission and repeat revascularization after percutaneous coronary intervention

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Abstract

Background: *Percutaneous coronary intervention (PCI) is one of the most frequently performed cardiac interventions. However, there is limited data regarding the cause of recurrent hospitalization and repeat revascularization. The aim of this study was to assess re-hospitalization and repeat revascularization within 30 days of the initial hospitalization for PCI, using data from Opolskie Voivodeship, National Health Fund (NHF) Registry.*

Methods: *The study population consisted of all PCI patients treated in three interventional cardiology laboratories in Opolskie Voivodeship in Poland between 1 July 2008 and 30 June 2009. All PCI patients who died during the initial hospitalization or who were transferred to other units were excluded from the analysis. The study end-point comprised 30 day all-cause readmission and repeat revascularization.*

Results: *A total of 2,039 PCI patients were included in the analysis. The all-cause 30-day readmission rate was 14.6%. The 30-day readmission rate of acute coronary syndrome (ACS) patients was significantly higher compared to the stable coronary disease patients (ACS 15.8%, non-ACS 10.7%, p = 0.008). The 30-day readmission rate did not differ between the three cardiac laboratories. Approximately half (46.2%) of all readmitted patients underwent a repeat revascularization procedure, mainly in the form of PCI. The overall all-cause 30-day mortality rate was 0.8%. Compared to the PCI patients who did not require readmission, the readmitted patients had a significantly higher all-cause 30-day mortality rate (3.6% vs 0.3%, p < 0.001).*

Conclusions: *Almost one in seven PCI patients requires readmission within 30 days of hospital discharge. Approximately 50% of all readmitted PCI patients resulted in a repeat revascularization procedure. PCI patients who were readmitted within 30 days of an index PCI procedure had a significantly higher all-cause 30-day mortality rate. (Cardiol J 2012; 19, 2: 174–179)*

Key words: percutaneous coronary intervention, repeat revascularization, 30-day readmission

Introduction

Percutaneous coronary intervention (PCI) is the most frequently performed cardiac intervention. Regardless of the epidemiological and outcomes data of ACS patients in Poland [1], available through the Polish National Registry of Acute Coronary Syndrome (PL-ACS) within the POLCARD program, the re-hospitalization rate, and the need for repeat revascularization in patients undergoing PCI, remains unknown. In 2009, there were a total of 2,636 PCIs performed per 1,000,000 people in Poland [2]. However, there is no National Health Fund (NHF) data on the frequency and cause of repeat hospitalizations in patients undergoing PCI. Thus, the objective of our study was to assess the need for re-hospitalization and repeat revascularization within the first 30 days after the initial PCI procedure using data from Opolskie Voivodeship, NHF Registry.

Methods

The study group comprised patients who were hospitalized and underwent PCI (according to ICD-9-CM) in three cardiac laboratories in Opolskie Voivodeship between 1 July 2008 and 30 June 2009. We don't have any detailed information about the exact time of intervention in patients with acute coronary syndrome (time from symptom onset and door-to-balloon time). An invasive strategy was implemented according to guidelines which were in force at the time of data collection [3, 4]. In case of ST-segment elevation myocardial infarction (STEMI), most PCIs were performed within 12 hours from the onset of pain, with time from first medical contact to balloon inflation less than two hours, and in case of non-ST-segment elevation acute coronary syndromes (NSTE-ACS) — within 72 hours. Pharmacological treatment was conducted according to current guidelines. The dose of aspirin in the acute phase was 150–325 mg (300 mg), the dose of clopidogrel 600 mg or 300 mg in some cases. Antithrombin therapy and GP IIb/IIIa antagonist therapy was conducted according to guidelines [3, 4]. Practically all patients received angiotensin converting enzyme inhibitors such as: enalapril, captopril, perindopril or ramipril; beta-blockers: bisoprolol, carvedilol, metoprolol or nebivolol and statins, if not contraindicated. Patients who had performed PCI received stents in 96% of cases. All PCI patients who died during the initial hospitalization or who required transfer to either a higher level of care or other departments were excluded from the
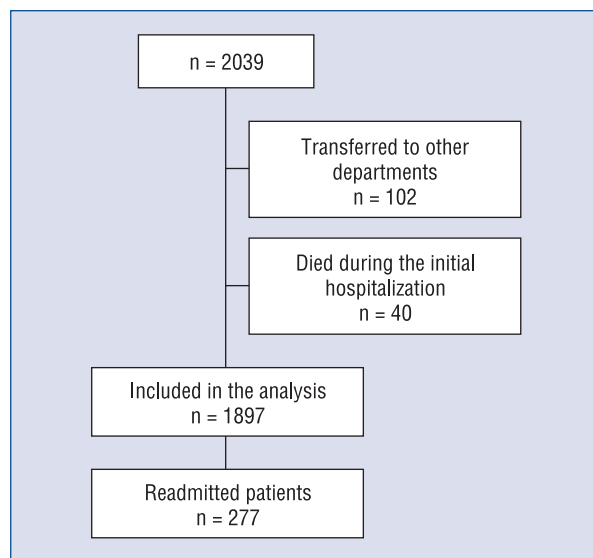

Figure 1. Patient population.

analysis. The primary end-point comprised all-cause 30-day re-hospitalization, defined as any readmission within 30 days from the initial hospitalization discharge date. Post discharge rehabilitation visits were excluded from the analysis and did not count as separate re-hospitalizations. The repeat revascularization was examined looking at the need for subsequent PCI or coronary artery bypass graft (CABG) surgery. All included patients also had their 30-day all-cause mortality rate examined. Furthermore, the groups of patients who underwent PCI with an implantation of a drug eluting stent — DES (E23 according to Diagnosis Related Groups, DRG) and two or more stents (E24 according to DRG) were studied. The baseline characteristics and their impact on measured variables were assessed. Statistical calculations were carried out using Statistica ver. 9. A two-tailed p value of < 0.05 was considered statistically significant.

The study was approved by the local bioethical committee.

Results

Of 2,039 patients who underwent PCI, 40 patients who died during the initial hospitalization, and 102 who were transferred to other units, were excluded from the analysis. The remaining 1,897 PCI patients (68.2% males; 65.7 years of age [mean]) were included in the analysis (Fig. 1). The overall all-cause 30-day mortality rate was 0.8%.

The overall readmission rate was 14.6% (n = = 277), and it differed between the patients with
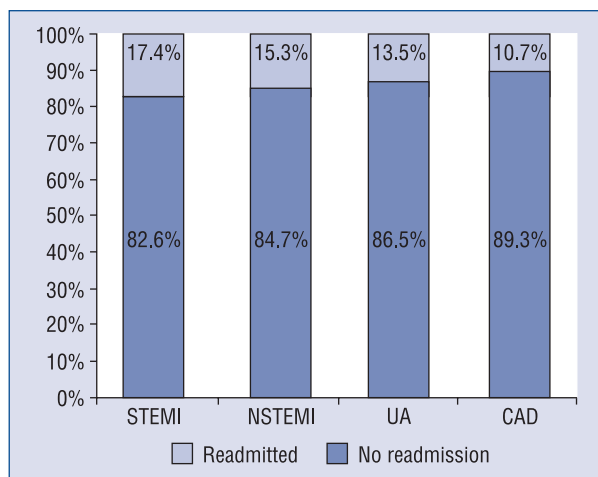
Figure 2. Readmission and primary clinical diagnosis; STEMI — ST-segment elevation myocardial infarction; NSTEMI — non-ST-segment elevation myocardial infarction; UA — unstable angina; CAD — stable coronary artery disease.

various primary diagnoses (Fig. 2). ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI) and unstable angina (UA) patients had significantly higher readmission rates compared to stable coronary artery disease (CAD) patients (ACS 15.8% vs non--ACS 10.7%, p = 0.008). Most of the studied patients were re-hospitalized once (68.6%). Consequent rehabilitation as a continuation of treatment after an index hospitalization was not counted as a re-hospitalization (575 patients).

Congestive heart failure (CHF) and chronic renal insufficiency were significantly associated with a greater readmission rate, as well as age. Patients with atrial fibrillation, atrio-ventricular conduction abnormalities, diabetes or peripheral artery disease, and women, were also shown to have higher readmission rates (Tables 1, 2). Importantly, readmitted patients had significantly higher mortality rates (3.6% vs 0.3%, p < 0.001).

The consequent re-hospitalization was strongly associated with a repeat revascularization (46.2%, n = 128) — staged PCI 35.0% vs PCI in acute MI 10.5% vs CABG 0.7%. Staged PCI was performed most frequently in STEMI patients. However, NSTEMI and UA patients were at highest risk for a repeat revascularization due to an acute cardiac event (Fig. 3).

Based on follow-up records, we analyzed the survival rates in the participating cardiac laboratories (Kaplan-Meier analysis). The 30-day readmission rate did not significantly differ (Opole vs both Nysa and Kędzierzyn-Koźle: 14.3% vs 15.1%, p = = 0.61) (Fig. 4, Table 3).

Compared to the Opole Medical Center, the smaller centers had significantly higher repeat revascularization rates in acute MI. Staged PCI was most frequent in the Opole Medical Center. Importantly, patients' baseline characteristics differed between the participating medical centers: patients admitted to the Opole Medical Center were more likely to be diagnosed with an acute STEMI (Table 3).

The reasons for hospital readmissions varied; the leading reasons were cardiac problems (79.4%),

Table 1. Re-hospitalization and 30-day all-cause mortality.

	Readmitted group (n = 277)	No readmission group (n = 1,620)	P
Male	66.1% (n = 183)	68.5% (n = 1,110)	0.42
Female	33.9% (n = 94)	31.5% (n = 510)	0.42
Age [years]	67.5	65.3	0.0014
Diabetes	32.5% (n = 90)	28.1% (n = 456)	0.14
Congestive heart failure	27.8% (n = 77)	18.6% (n = 301)	< 0.001
Chronic renal insufficiency	9.4% (n = 26)	4.6% (n = 74)	< 0.001
Hypertension	75.1% (n = 208)	76.8% (n = 1,244)	0.54
Peripheral artery disease	29.2% (n = 81)	25.6% (n = 414)	0.20
Bradyarrhythmia	6.1% (n = 17)	4.4% (n = 71)	0.20
Atrial fibrillation	11.6% (n = 32)	8.3% (n = 134)	0.07
Cardiac arrest	1.4% (n = 4)	1.1% (n = 18)	0.63
PCI with DES	10.5% (n = 29)	10.8% (n = 175)	0.87
PCI ≥ 2 stents or multivessel	2.5% (n = 7)	3.3% (n = 54)	0.48
30-day mortality	3.6% (n = 10)	0.3% (n = 5)	< 0.001

DES — drug-eluting stent; PCI — percutaneous coronary intervention

Table 2. Multivariate logistic regression analysis of factors predicting readmission.

Factor	Odds ratio	95% CI		P
Gender	1.02	0.77	1.35	0.89
Age	1.01	1.00	1.03	0.04
Diabetes	1.12	0.84	1.49	0.44
Congestive heart failure	1.52	1.10	2.09	0.01
Chronic renal insufficiency	1.70	1.04	2.79	0.03
Hypertension	0.85	0.62	1.15	0.29
Peripheral artery disease	0.91	0.66	1.26	0.59
Bradyarrhythmia	1.10	0.62	1.95	0.74
Atrial fibrillation	1.16	0.75	1.78	0.50
Cardiac arrest	1.40	0.46	4.26	0.55
PCI with DES	0.96	0.63	1.47	0.85
PCI ≥ 2 stents or multivessel	0.75	0.34	1.69	0.49

CI — confidence interval; DES — drug-eluting stent; PCI — percutaneous coronary intervention
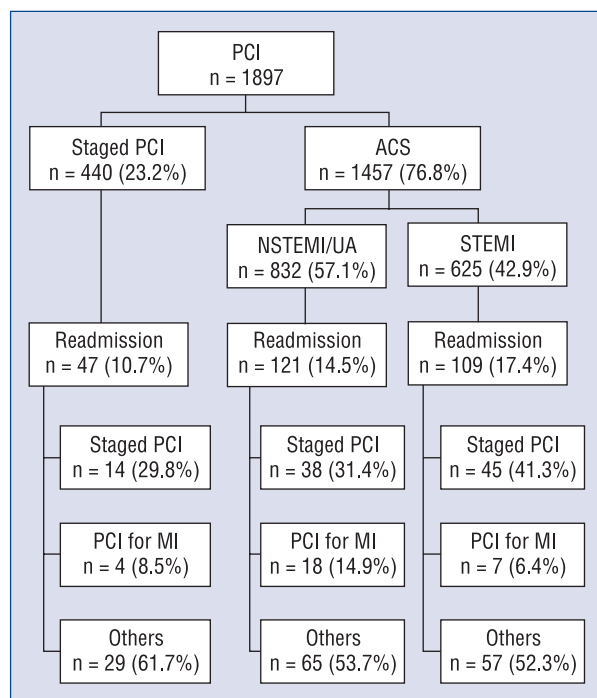

Figure 3. Cause of repeat revascularization (staged, in acute coronary syndromes) and 30-day re-hospitalization; PCI — percutaneous coronary intervention; ACS — acute coronary syndrome; MI — myocardial infarction; rest abbreviations as in Figure 2.

Figure 4. Kaplan-Meier survival analysis in the participating medical centers.

followed by gastrointestinal (5.1%), cerebrovascular (2.2%), cancer (2.2%), diabetes and its complications (1.8%), respiratory (1.4%), renal insufficiency (1.1%) and others (6.9%). Of all the readmitted patients, patients with stable coronary disease 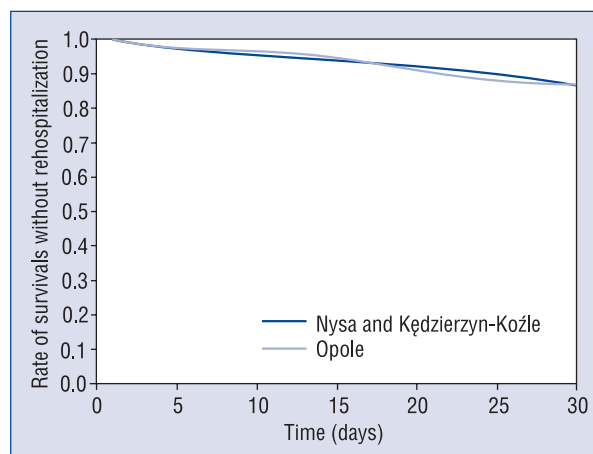accounted for 44.4%, MI and UA — 18.8%, CHF — 9.0%, cardiac arrhythmias — 2.9%, cardiac arrest — 0.4% and others, such as structural heart disease and hypertension, 4.0%.

Discussion

Of all PCI patients, one in seven required a repeat hospitalization within 30 days of discharge. Approximately 50% of all readmitted PCI patients underwent a repeat revascularization procedure. PCI patients who were readmitted within 30 days of an index PCI procedure had a significantly higher all-cause 30-day mortality rate. Curtis et al. [5] reported a 14.6% rate of 30-day readmission based on their analysis of 315,241 patients aged 65 and older who underwent PCI in 1,108 invasive cardiology

Table 3. Comparison of participating medical centers.

	Opole (n = 1,217)	Kędzierzyn-Koźle and Nysa (n = 680)	P
Primary clinical diagnosis			
STEMI	37.8% (n = 460)	24.3% (n = 165)	< 0.001
NSTEMI	25.4% (n = 309)	27.6% (n = 188)	0.28
UA	15.4% (n = 188)	21.5% (n = 146)	< 0.001
Stable coronary disease	21.3% (n = 259)	26.6% (n = 181)	0.008
Rehospitalization	14.3% (n = 174)	15.1% (n = 103)	0.61
Repeat revascularization	42.0% (n = 73)	53.4% (n = 55)	0.06
PCI for MI*	9.6% (n = 7)	40.0% (n = 22)	< 0.001
Other reasons	58.0% (n = 101)	46.6% (n = 48)	0.06

*Percentage of total repeat revascularization number; abbreviations as in Figures 2 and 3

centers in the USA in 2005. The reported repeat revascularization rate was 27.5%. The readmission rate ranged from 8.9% to 22% between hospitals, and was significantly higher in patients with acute MI than in non-acute MI patients (17.5% *vs* 13.6%).

It appears that early re-hospitalization is associated with coexisting cardiac conditions. On the contrary, the 30-day readmission rate could be a function of the quality of in-hospital and early post discharge care; however, the results need to be confirmed by larger studies. The reported one-year readmission rate of patients undergoing PCI ranges between 29–31% in the United States [6].

Based on the 2009 data, there were 2,636 PCIs performed for every million people in Poland, while the overall mean in Opolskie Voivodeship was 2,916 PCIs/1,000,000 [2]. There were three 24/7 cardiology laboratories in this region which participated in the study. Compared to the lower volume centers, i.e. Nysa and Kędzierzyn-Koźle, where most of the UA and stable coronary disease patients were referred to hospital, hospitalizations of STEMI patients were more common at the Medical Center in Opole. The discussed difference could be caused by the longer-established nature and better relationship with referring facilities of the Medical Center in Opole. The 30-day readmission rate did not differ between the Medical Center in Opole and the other participating hospitals with lower overall PCI volume. There were differences in repeat revascularization rates, in particular in patients presenting with an acute MI. The observed pattern could be due to the fact that the reference centers tend to receive sicker patients. On the other hand, the bigger centers focus on long-term care including staged PCI procedures, frequently scheduled at the time of an initial visit.

The reasons for readmission after PCI can be categorized into several groups, such as procedural complications (bleeding, coronary vessel occlusion, contrast induced nephropathy), planned revascularization and consequences of coexisting diseases and risk factors. Cardiac problems were the commonest cause of readmissions in the study group (79.4%). One of the limitations of the paper is that the data about acute complications after PCI was not analyzed.

Patients who had a PCI performed received stents in 96% of cases. The number of PCIs with DES implantation may appear to be low, but the strategy was that drug-eluting stents were used mainly during staged procedure at that time and bare-metal stents were used practically in all patients with myocardial infarction. The limitations of the study included a lack of detailed information of the initial procedure (e.g. number of stents) which could have played an important role in the success of the treatment provided. The percentage of patients treated with GP IIb/IIIa inhibitors wasn't estimated. The remaining coronary vessel characteristics have not been analyzed further; we did not examine whether or not the repeat revascularization was performed in the same vessel (including in-stent restenosis etc.).

It is also impossible to determine whether the initial intervention was a staged PCI procedure for a multivessel CAD. Such information could have helped in explaining a surprisingly high repeat revascularization rate in acute MI patients who presented initially with NSTEMI and UA. An increased rate of repeated revascularization in acute MI patients in this group could be explained by an inadequate and difficult recognition of a culprit lesion in patients with multivessel CAD. Compared to the

acute MI patients who underwent PCI only in the culprit lesion, the acute MI patients who underwent complete revascularization had significantly lower MI and repeat revascularization rate during the two years of follow-up [7].

It has been reported that improved quality of PCI and post PCI care is associated with better clinical outcomes, including fewer complications and lower rates of the composite end-point consisting of death, cardiovascular accidents and repeat revascularization [8]. Furthermore, the lower re-hospitalization rate of CHF patients has been described in patients who received specialized treatment and were followed closely after discharge [9]. There are also other essential components in patients undergoing PCI, such as an institutional profile of the healthcare system, quality of the in-hospital and post-discharge care, as well as the aspect of compliance with post-discharge antiplatelet medication regimen. The presented outcomes require a long-term observation to determine the best solution to reduce the re-hospitalization rate and, consequently, the cost of medical care.

Conclusions

The readmission rate was highest in patients who presented initially with STEMI, and lowest in patients with stable CAD. The readmitted patients were more likely to be elderly and female. The planned revascularization was performed most frequently in patients with STEMI as an initial presentation. The NSTEMI and UA patients were required to undergo repeat revascularization most frequently for acute MI. Readmission rates were comparable between the participating hospitals. The independent predictors of increased risk of re-hospitalization were: coexistent CHF, chronic renal failure, and older age.

Acknowledgements

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