Redesigning cardiovascular healthcare: patient and professional perspectives on value

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CHAPTER III

MYOCARDIAL INFARCTION CARE IN LOW AND HIGH SOCIOECONOMIC ENVIRONMENTS - CLAIMS DATA ANALYSIS

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Submitted

Abstract

Background

Claims data have not yet been used to study outcome differences between low and high Socio Economic Status (SES) patients surviving ST elevation myocardial infarction (STEMI) and non-ST elevation myocardial infarction (NSTEMI).

Objective

To evaluate STEMI and NSTEMI care among patients with low and high SES in the referral area of three Dutch percutaneous coronary intervention (PCI) centres, using claims data as a source.

Methods

STEMI and NSTEMI patients treated in 2015-2017 were included. Patients' SES scores were collected based on ZIP-code via an open access government database. In low (SES1) and high (SES4) patients, revascularisation strategies and secondary prevention medication were compared.

Results

2,022 SES1 patients (age 68±13 years, 58% NSTEMI) and 1,635 SES4 patients (age 68±13 years, 63% NSTEMI) were included. PCI use was lower in SES1 compared to SES4 in both STEMI (80% vs 84%, p<0.012) and NSTEMI (42% vs 48%, p<0.002).

CABGs were performed more often in SES1 compared to SES4 in both STEMI (7% vs 4%, p=NS) and NSTEMI (11% vs 7%, p<0.001). Optimal medical therapy use in STEMI patients was higher in SES1 compared to SES4 (52% vs 46%, p=0.01); among NSTEMI this was comparable (39% vs 40%, p=NS). One-year mortality was comparable between SES1 and SES4 in STEMI (14 vs 16%, p=NS), and NSTEMI (10% vs 11%, p=NS).

Conclusion

Combined analysis of claims data and area specific socioeconomic statistics can provide unique insight on how to improve myocardial infarction care for low and high SES patients.

Abbreviations

ATC	Anatomic Therapeutic Chemical code
CABG	Coronary Artery Bypass Graft
DDD	Daily Defined Dosage
NSTEMI	non-ST elevation myocardial infarction
OMT	Optimal Medical Therapy
PCI	Percutaneous Coronary Intervention
SCP	The Netherlands Institute for Social Research (Sociaal en Cultureel Planbureau)
SES	Socioeconomic Status
STEMI	ST elevation myocardial infarction
ZINL	Dutch National Healthcare Institute (Zorginstituut Nederland)

Introduction

Socioeconomic status (SES) provides insight in the welfare level of an area and its inhabitants on various components including education, income and employment(1, 2). In patients with coronary artery disease, previous studies reported that low SES associated with increased morbidity and mortality (3-7). Therefore, low SES is a risk factor for a worse outcome in ST elevation myocardial infarction (STEMI) and non-ST elevation myocardial infarction (NSTEMI) patients.

Improving socioeconomic environment is foremost a governmental matter. However, cardiologists and allied professionals should be concerned with the evaluation and improvement of clinical care after myocardial infarction in different socioeconomic environments. Prospective registry-based studies can provide insight in demographic, ethnic and SES differences among myocardial infarction patients(7-9). Despite being executed well, these studies are often laborious and limited to selected patients. Contemporary databases, such as claims data registries, provide a unique alternative to assess outcomes of patients surviving myocardial infarction, as these databases provide accurate 'real world' data (10-12). To date, claims data has not been used to study differences between low and high SES myocardial infarction patients.

The current 'proof of concept' study evaluates STEMI and NSTEMI care among patients with low and high SES in the referral area of three Dutch percutaneous coronary intervention (PCI) centres, using claims data as a source. In particular, revascularisation strategies, secondary preventive medication-use and one-year mortality after STEMI and NSTEMI are analysed. The results of the current study may ultimately help to develop improvement strategies for modifiable factors on a loco-regional level.

Methods

In the Netherlands, hospital - and pharmaceutical claims data are sent to patient's insurance companies and subsequently collected in the central database of the insurance companies. The current study was done in close collaboration with the Dutch National Healthcare Institute (ZINL) which has an advisory role to the Dutch government and has access to both hospital- and pharmaceutical claims databases.

Study Design

This is a retrospective cohort study. Pseudo-anonymous and encrypted patient data were used. Dutch law states that prior ethical review and approval is not necessary for this type of analysis. Access to the claims data of each hospital was granted after obtaining signed consent from the head of the cardiology departments from each of the participating hospitals.

Study Population and Data Collection

All adult myocardial infarction patients treated in three participating Dutch PCI centers (two on-site; Leeuwarden Medical Center and Leiden University Medical Center, and one off-site PCI center, North-West Hospitals - Alkmaar) were eligible for inclusion. Inclusion criteria were: (1) diagnosis of STEMI (claims code 0320.11.204) or NSTEMI (claims code 0320.11.205) between January 1st 2015 and December 31st 2017, (2) follow-up of at least one year in one of three participating hospitals and (3) patients residing in surrounding ZIP-codes of participating hospitals (appendix 1). As described below, ZIP codes were used to classify patients in SES classes: SES1 was the lowest class and SES4 was the highest class. As the scope of the study was to compare myocardial infarction care in the lowest (SES1) vs. in the highest SES (SES4), patients in SES2 and SES3 were excluded. Patients who had more than one myocardial infarction during the study period were also excluded. Demographic data, revascularization strategies, medication use, and one-year mortality were evaluated in patients.

Socioeconomic Status (SES) Score

SES-scores are calculated for all ZIP-codes in the Netherlands by the Dutch government (Netherlands Institute for Social Research (SCP)) and are available through an online open-access database. The SES-score of a ZIP-code provides insight in the welfare status of that area. Scores are based on yearly income, employment status and education(13, 14). The average national SES-score score has a given numerical value of 0. This numerical vector changes by diverse variables: low income and low educational level result in a low numerical SES-score values, higher income and educational level result in higher numerical SES-score values. Between 2015 and 2017, Dutch national SES-scores were divided in four quartiles with the lowest SES score being SES1 and the highest SES score being SES4.

The SES quartiles were classified as follows: SES1: -8.19 to -0.57, SES2: -0.57 to 0.15, SES3: 0.15 to 0.71, SES4: 0.71 to 2.93.

Outcome Measure – Revascularisation

Revascularisation through either PCI or coronary artery bypass grafting (CABG) was assessed. PCI was defined as patients 'having had an angiography *with* placement of a stent or balloon angioplasty within four days of the initial STEMI or NSTEMI diagnosis registration'. The cut-off of 4 days was based on European and American guidelines, which recommend an invasive strategy within the first 72 hours (the acute or semi-acute phase of the STEMI or NSTEMI)(15-17).

CABG was defined as patients 'having had bypass surgery within 30 days of initial STEMI or NSTEMI diagnosis registration'. PCI or CABG at different time intervals were not analyzed in the current study. In addition, the total amount of re-PCI or re-CABG procedures were not analyzed.

Outcome Measure – Optimal Medical Treatment

Optimal medical treatment (OMT) after myocardial infarction was defined as the *combined* use of an aspirin specie, a P2Y12- inhibitor, a statin, a betablocker and an ACE-/AT2-inhibitor as recommended by international STEMI and NSTEMI guidelines(15, 16). For all patients, OMT use was measured one year after the initial STEMI or NSTEMI diagnosis registration, extracted from the national pharmacy database as a combination of anatomical therapeutic chemical (ATC) codes together with DDD of that type of medication. For each drug, a DDD threshold of at least 10 dosage-units per day during one year was used. The DDD is composed by the World Health Organization Collaborating Centre for Drug Statistics Methodology. It is the assumed average maintenance dose for a drug used for its main indication in adults. The use of these ATC and DDD definitions per medication has been validated in previous studies(10).

Statistical Analysis

Data are presented as absolute numbers and as a proportion of the total population (%). Proportion comparisons were done by a X^2 test. A p-value of 0.05 was considered statistically significant. Data were analyzed using SPSS version 25™ (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.)

Results

Study Population

During the study period, 7,264 unique myocardial infarction patients were treated in the participating hospitals. After exclusion of the SES 2 and SES 3 patients, the study population comprised 3,704 patients. Of these, 2,065 (28%) were SES1 patients and 1,639 (23%) were SES4 patients (Table1). In both groups, the majority concerned NSTEMI patients: 1,195 (58%) in the SES 1 group and 1,040 (63%) in the SES 4 group. Mean age at the time of STEMI and NSTEMI was similar in SES1 and SES4 patients (table 1). Significant less males were present in the SES1 group compared to SES4 group in STEMI patients (64% vs 74%, P<0.001) and to a lesser extent in NSTEMI patients (65% vs 66%, P=0.02). One-year mortality in SES1 and SES4 was similar in STEMI (14% vs 16%) and NSTEMI (11% vs 10%) patients (P=NS).

Table 1. Demographics of AMI patients within socioeconomic classes 2015-2017

SES	SES1	SES4	p-value
AMI (N)	2,065	1,639	
STEMI (N,%)	870(42)	599(37)	
Age (Mean,SD)	66.5(13)	66.7(13)	NS
Male (N,%)	551(64)	322(74)	<0.001
1-year mortality (N,%)	121(14)	70(16)	NS
NSTEMI (N,%)	1,195(58)	1,040(63)	
Age(Mean, SD)	70.5(13)	70.4(12)	NS
Male (N,%)	759(65)	612(66)	0.02
1-year mortality (N,%)	134(11)	94(10)	NS

AMI = Acute Myocardial Infarction; NS = Not Significant; NSTEMI = non ST elevation myocardial infarction; STEMI = ST elevation myocardial infarction

Table 2. PCI and CABG in STEMI and NSTEMI by SES.

SES	SES1	SES4	p-value
STEMI (N=)	870	599	
PCI(N,%)	697(80)	508(84)	0.02
CABG-30(N,%)	59(7)	22(4)	0.01
NSTEMI (N=)	1195	1040	
PCI(N,%)	505(42)	505(48)	0.003
CABG-30(N,%)	136(11)	72(7)	<0.001

CABG-30 = coronary artery bypass graft, within 30 days of admission

NSTEMI = non ST elevation myocardial infarction; PCI = percutaneous coronary intervention, within 4 days of admission; SES = socioeconomic status;

STEMI = ST elevation myocardial infarction

Revascularization by SES

Table 2 and figures 1a and 1b show treatment by PCI and CABG among STEMI and NSTEMI patients stratified by SES. In both STEMI and NSTEMI patients, PCI procedures were significantly less frequently performed in SES1 patients as compared to SES4 patients (P=0.02 for STEMI and P=0.003 for NSTEMI). On the contrary, in both STEMI and NSTEMI patients, CABG procedures were more often performed in SES1 patients compared to SES4 patients (P=0.01 for STEMI and P<0.001 for NSTEMI).

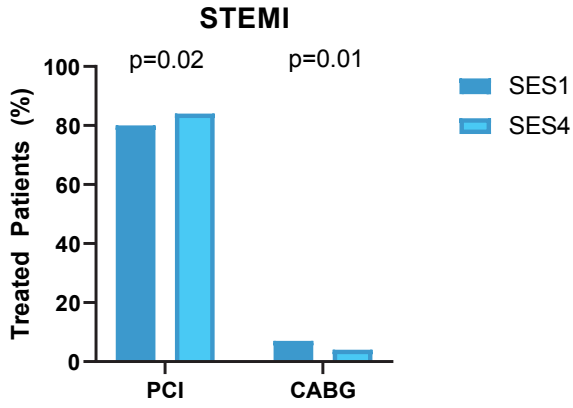

Figure 1a. Total P-CI and CABG in STEMI stratified by SES.

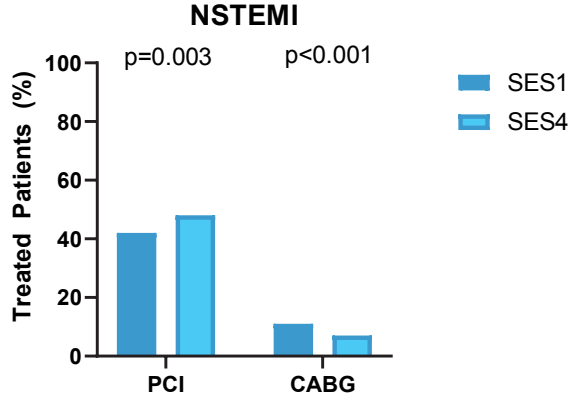

Figure 1b. Total PCI and CABG in NSTEMI stratified by SES.

Medication Usage by SES

Table 3 and figure 2 show medication use by STEMI and NSTEMI patients stratified by SES. Following STEMI, SES1 patients more frequently used complete optimal medical therapy as compared to SES4 patients (52% vs. 46%, P=0.01). The higher rate of medication use by SES1 patients was driven by a higher use of aspirin (84% vs. 76%, P<0.001), P2Y12-inhibitors (80% vs. 76%, P=0.03), betablockers (64% vs. 54%, P<0.001) and statins (84% vs. 77%, P<0.001). Following NSTEMI, 39% of SES1 patients used complete optimal medical therapy as compared to 40% of SES4 patients (P=NS). The only difference in NSTEMI patients concerned P2Y12-inhibitors with a lower use in SES1 patients (72% in SES1 vs. 76% in SES4, P=0.01).

Table 3. OMT and individual medication use among STEMI and NSTEMI patients by SES.

STEMI	**SES1**	**SES4**	**p-value**
OMT(N,%)	455(52)	274(46)	0.01
ASA(N,%)	728(84)	453(76)	<0.001
P2Y12(N,%)	699(80)	453(76)	0.03
BB(N,%)	557(64)	323(54)	<0.001
ACE/AT2(N,%)	653(75)	423(71)	NS
STAT(N,%)	734(84)	461(77)	<0.001
NSTEMI			
OMT(N,%)	466(39)	413(40)	NS
ASA(N,%)	984(82)	881(85)	NS
P2Y12(N,%)	856(72)	794(76)	0.01
BB(N,%)	705(59)	641(62)	NS
ACE/AT2(N,%)	844(71)	725(70)	NS
STAT(N,%)	992(83)	870(84)	NS

ACE/AT2 = angiotensin converting enzym/angiotensin II recepter blocker; ASA = Aspirin-specie; BB = Betablocker; OMT = Optimal Medical Treatment; P2Y12 = Thienopyridine antagonists; SES = socioeconomic status; Stat = Statin

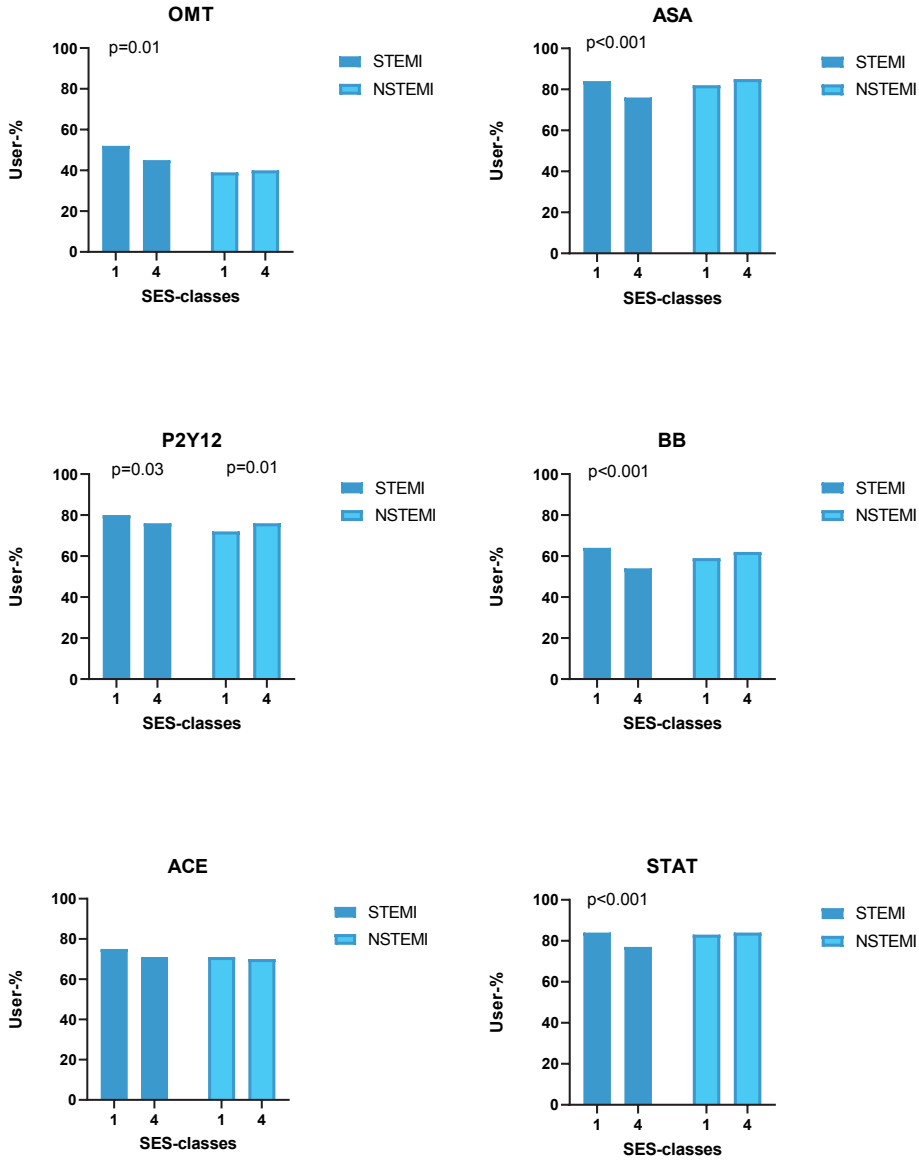

Figure 2. OMT and individual medication use among STEMI and NSTEMI patients by SES.

Discussion

The main findings of the current study, analyzing STEMI and NSTEMI care among low and high SES patients with the use of claims data, can be summarized as follows. At first, in both STEMI and NSTEMI patients, SES1 patients were less frequently treated by PCI and more frequently by CABG as compared to SES4 patients. At second, the use of optimal medical therapy is overall moderate in both SES1 and SES4 patients. Following STEMI, SES1 patients more frequently use complete optimal medical therapy as compared to SES4. Following NSTEMI, there is no difference in the rate of complete optimal medical therapy use. Lastly, combining claims data and area specific socioeconomic statistics, can be an efficient method to analyze cardiac care on a loco-regional level in a unique way.

A main finding of the current study is that low SES patients with either a STEMI or a NSTEMI, are treated by CABG more frequently than high SES patients. High CABG frequencies among low SES patients most probably are the result of more complex coronary lesions, resulting in the need for a CABG in this patient category.

Previous studies have shown that low SES patients overall exhibit more risk factors (smoking) and comorbidities (including hypertension, hypercholesterolemia and diabetes) at presentation resulting in multivessel disease rather than one-vessel disease (18-20). The relatively high frequency of CABGs in the low SES patients suggests that this population has an unhealthier life-style.

Thereby, the findings of the current study provide rationale for a conjoined initiative of cardiologists, family physicians, health care insurance companies and policy makers to improve life style in low SES regions.

In the current study, the use of optimal medical care is modest, both among STEMI and NSTEMI patients as well as among low and high SES patients. This finding is in line with previous Dutch (10, 12, 21), British and American studies (22-24), all stressing the need for increased awareness and improvement on this topic. When addressing individual medication use after STEMI in SES classes, foremost aspirin, betablockers and statins are used more frequently by low SES patients than by high SES STEMI patients. In NSTEMI patients, low and high SES patients show an overall comparable low usage pattern.

Although some previous studies show that low SES has a negative effect on medical adherence(25, 26), others show a negative effect of high SES(27, 28), or no effect of SES on medical adherence(29). The reason for the observed difference in our study is difficult to distill, as no clinical data such as allergies or side effect patterns were used. A lower use of cardioprotective medication in high SES STEMI patients can be related to an unwillingness

to take medication because of doubts or fear of side-effects, observed in higher educated patients(23, 30). It could however also be related to a healthier life-style and less prevalent risk-factors. The fact that, in the current study, high SES STEMI patients less frequently use optimal medical therapy is an important finding for the hospitals participating in the current study.

As medical adherence is indispensable for survival after myocardial infarction, initiatives focusing on medication adherence in the high SES patients in the outpatient follow-up by cardiologist and primary care physicians are warranted.

Future Perspectives

The use of financial claims data to analyze healthcare at a system level has recently gained attention. In the present study, for the first time, these claims data are combined with area specific socioeconomic statistics. Thereby, the study illustrates that in this way treatment patterns and healthcare use in specific regions and specific patient groups can be analyzed. This type of research substantially differs from previously performed "causality studies" with claims data assessing the impact of low SES on mortality or adverse events after myocardial infarction (19, 31-33).

The current findings in myocardial infarction patients, stress the importance of developing primary prevention programs in low SES regions. In addition, it provides rationale for developing programs to improve medical adherence after myocardial infarction among inhabitants of high SES regions. Conceptually, developing specific programs for specific inhabitants of specific regions may increase the effectiveness of these programs and contribute to a more useful spending of scarce healthcare resources.

Limitations

Some limitations should be considered when interpreting the results. First, the study uses observational data. Second, the used SES value is a ZIP-code average: some SES4 patients might live in an SES1 area and vice versa. Third, the used definition of SES is on an area bound-level, not on an individual level. Fourth, the level of clinical details is limited. Accordingly, completeness of revascularization, ventricular function or infarct size are not included and commonly used risk scores (e.g. GRACE risk score) cannot be applied to our study population. Fifth, the claims databases are gradually filled over a period of 2 years. Accordingly, the coverage of the 2018 and later databases were not available when this study was conducted. Lastly, the total amount of CABGs in our population could be underestimated by the fact that one off-site PCI center was included.

Conclusion

Combined analysis of claims data and area specific socioeconomic statistics can provide unique insight on how to improve myocardial infarction care for low and high SES patients. The relatively high CABG frequency among low SES patients stresses the importance of primary prevention programs in low SES regions.

The relatively low rate of complete optimal medical therapy justifies the development of programs to improve medical adherence among high SES patients.

Conflicts of Interest

none declared.

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none received.

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Appendix 1. Included zip-codes of analyzed PCI centers.

Leeuwarden Medisch Centrum (on-site PCI center)

- 8411 – 8495
- 8601 – 8651
- 8851 – 8584
- 8701 – 8773
- 8800 – 8896
- 8911 – 8941
- 9001 - 9089
- 9100 – 9178
- 9251 - 9265
- 9257 – 9269
- 9271 – 9298
- 9851 - 9853
- 9950

Leiden University Medical Center (on-site PCI center)

- 2171 - 2191
- 2201 - 2254
- 2311 – 2361

Noordwest Ziekenhuisgroep – Alkmaar (off-site PCI center)

- 1483 – 1486
- 1536
- 1631 - 1652
- 1711 - 1797
- 1811- 1873
- 1901 – 1992
- 2071 - 2082