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Differences in clinical characteristics between patients with and without type 2 diabetes hospitalized with a first myocardial infarction

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ABSTRACT

Aims: To explore differences in clinical characteristics of patients with and without type 2 diabetes (T2DM) hospitalized with a first myocardial infarction (MI).
Methods: In this cross-sectional study we examined differences between patients with and without T2DM hospitalized with a first MI (n = 563). Multiple linear regression modeling was used to examine the association between T2DM and age of occurrence of MI. We adjusted for gender, systolic blood pressure (BP), lipids and creatinine level to examine whether these variables explained the association between T2DM and age of occurrence of MI.
Results: Among 563 patients with a first MI, T2DM patients ($n = 77$) were older than non-diabetic patients (67.8 ± 10.9 vs. 64.4 ± 13.4 years, $p < 0.05$), had lower LDL (2.5 ± 0.8 vs. 3.4 ± 1.1 mmol/l, $p < 0.001$) and total cholesterol levels (4.4 ± 0.9 vs. 5.4 ± 1.2 mmol/l, $p < 0.001$), but higher systolic BP (150.3 ± 29.9 vs. 141.7 ± 27.5 mmHg, $p < 0.05$). The association between T2DM and age of occurrence of MI was largely explained by cholesterol levels.
Conclusions: T2DM patients were older when hospitalized with a first MI. This difference was largely explained by differences in cholesterol levels. The lower cholesterol levels in T2DM patients compared to non-diabetic patients, and maybe also the older age of occurrence of MI, might reflect the results successful primary prevention and systematic monitoring in T2DM.

1. Introduction

Type 2 diabetes is associated with an increased risk of cardiovascular events (Huxley, Barzi, & Woodward, 2006), but has improved significantly during the last decades (Ford, 2011). The rate of cardiovascular events decreased from 3% to 2% in type 2 diabetes (Stone et al., 2013). This decrease may be the result of the implementation of guidelines for type 2 diabetes, which recommend to aim for an LDL cholesterol below 2.6 mmol/l, by using statins as the drug of choice. A reduction of 1 mmol/L LDL cholesterol reduces the incidence of cardiovascular morbidity and mortality in type 2 diabetes patients by 20% (Baigent et al., 2005).

Good adherence, to key recommended process measures, was found in a study including eight European countries. This means that type 2 diabetes patients get their HbA1c, blood pressure and lipid levels measured on a regular basis (Stone et al., 2013). Lipid lowering drugs were prescribed in two out of three of the type 2 diabetes patients. In the ADDITION-study, people were screened for type 2 diabetes. After three years of follow-up, patients without diabetes but with an elevated cardiovascular risk score received a less optimal control for their cardiovascular risk factors, while screen-detected diabetic patients were controlled adequately (Janssen, Gorter, Stolk, Akarsubasi, & Rutten, 2008). This indicates that having the diagnosis diabetes can be favorable for controlling risk factors and decreasing the cardiovascular risk. Furthermore, it is known from recent studies that type 2 diabetes patients were slightly older than non-diabetic patients when hospitalized with a myocardial infarction (MI) (Elbarouni et al., 2011; Norhammar et al., 2003), although they had a worse cardiovascular profile.

This study aimed to explore differences in clinical characteristics of patients with and without type 2 diabetes hospitalized with a first MI, to assess whether these differences reflect the results of the intensified primary in type 2 diabetes. We specifically focused on the difference in age of occurrence of a first MI.

2. Material and methods

2.1. Study population

Data for this cross-sectional study were collected from three non-university teaching hospitals in the Netherlands. Data were

Conflicts of interest: none.

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obtained from all patients hospitalized with a first or recurrent ST-elevation MI (STEMI; ICD-10 I21.03–I21.3) or Non-ST-elevation MI (NSTEMI; ICD-10 I21.4) between June 2010 and June 2011. Patients were excluded when they had type 2 diabetes de novo, type 1 diabetes and/or were younger than 35 years.

2.2. Measurements

All patient characteristics were extracted from the electronic medical records. Data on systolic blood pressure (BP), blood lipids (total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides), creatinine, non-fasting glucose and HbA1c at hospital admission were extracted. Biochemical tests were performed in each participating hospital's laboratory. LDL cholesterol levels were calculated by the laboratories with the Friedewald's formula. Between the types of intervention we distinguished conservative therapy, percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG). The age of occurrence of an MI was defined by age at which the patients were hospitalized with a first MI. Type of MI is used as a measure of severity of MI. A STEMI is considered more severe and associated with more cardiovascular damage compared to an NSTEMI (Johnson et al., 1999). Furthermore, it was evaluated whether a history of type 2 diabetes, hypertension, hypercholesterolemia or atrial fibrillation (AF) was reported in the electronic medical file. We calculated the cardiovascular risk score using the Systematic Coronary Risk Evaluation (SCORE) algorithm (Conroy et al., 2003). Each individual was categorized into a risk category based on age, sex, smoking status, systolic blood pressure and the total cholesterol/HDL cholesterol ratio. In the Dutch guidelines, for type 2 diabetes, the patient's aged used for risk estimation is increased by 15 years.

2.3. Statistical analysis

Multiple imputation modeling was used to impute missing data (SPSS MVA procedure; SPSS, Inc., Chicago, IL). We generalized 10 imputed datasets and used Rubin rules to combine the estimates of the parameters (D R, 1987).

For the main analyses, patients with a first MI were included. Categorical variables were reported as numbers and percentages, normally distributed continuous variables as means with standard deviations (SD), and non-normally disturbed continuous variables as median with interquartile ranges (IQR). We explored differences in patient characteristics and type of intervention between type 2 diabetes patients and individuals without diabetes with Chi-square tests, independent T-tests and Mann Whitney U tests. To evaluate differences on severity of MI between patients with and without diabetes, we compared proportions of type of MI for the two groups with a Chi-square test. To determine whether type 2 diabetes is associated with the age of occurrence of MI, linear regression modeling was used with age of occurrence of MI as dependent variable and type 2 diabetes as independent variable. Multiple linear regression analyses were used to adjust for gender, systolic BP, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides and creatinine level, to evaluate whether these variables explained the association between type 2 diabetes and age of occurrence of MI. Furthermore, differences in age between patients with and without type 2 diabetes hospitalized with a recurrent MI were also explored.

Protocol issues resulted in high amounts of missing biochemical data. In a sensitivity analysis we excluded patients from the hospital with a high amount of missing biochemical data to examine the impact of these missing values. Additional analyses stratified by gender were performed to examine the impact of gender on the results.

All analyses were performed using the SPSS version 20.0.

3. Results

Missing data for most parameters were below 5.7%, except for systolic BP (19.3%), history of hypercholesterolemia (18.5%) and smoking (19.9%). One hospital did not routinely measure triglycerides, HDL cholesterol, LDL cholesterol and HbA1c. As a result, triglycerides (35.3%), HDL (35.3%) and LDL cholesterol (36.1%) and HbA1c (66.7%) measurements showed relatively high levels of missing values. The presence of missing values was not related to other variables.

Characteristics of patients hospitalized with a first MI ($n = 563$), of which 14% had type 2 diabetes, are presented in Table 1. Type 2 diabetes patients hospitalized with a first MI were significantly older than non-diabetic patients and had lower LDL and total cholesterol levels, but had a higher cardiovascular risk score (Fig. 1). The discrepancy between diabetes patients and non-diabetes patients in age of occurrence of MI was also found in patients hospitalized with a recurrent MI (72.5 ± 11.4 years vs. 66.8 ± 13.6 years, $p < 0.05$).

Furthermore, in the first MI group diabetes patients had a higher systolic blood pressure, higher levels of triglycerides and higher levels of creatinine compared to non-diabetic patients. As expected, they had higher glucose and HbA1c levels. Type 2 diabetes patients more often had a history of hypertension, hypercholesterolemia and AF. Type 2 diabetes patients and non-diabetic patients did not differ in type of MI. Also, no differences in type of intervention were found.

Results of the multiple linear regression analyses are presented in Table 2. Type 2 diabetes was associated with the occurrence of a first MI at an older age. After adjusting for total and LDL cholesterol, the association between diabetes and age of occurrence of MI was no longer significant. A trend remained after adjusting for systolic BP and creatinine. The association between type 2 diabetes and age of occurrence of MI remained significant after adjusting for gender, HDL cholesterol and triglycerides.

A sensitivity analysis showed that excluding the patients from the hospital with a high amount of missing values did not considerably affect the results (data not shown). In analysis stratified by gender, similar results for men and women were found (data not shown).

Table 1
Characteristics of patients with a first MI.

	Non-diabetic (n = 486)	Type 2 diabetes (n = 77)	*p*-value
Age (years)	64.4 ± 13.4	67.8 ± 10.9	<0.05
Male gender (%)	72.8	71.4	0.785
Smoking (%)	45.9	39.0	0.318
Systolic BP (mmHg)	141.7 ± 27.5	150.3 ± 29.9	<0.05
Total cholesterol (mmol/l)	5.4 ± 1.2	4.4 ± 0.9	<0.001
LDL cholesterol (mmol/l)	3.4 ± 1.1	2.5 ± 0.8	<0.001
HDL cholesterol (mmol/l)	1.3 ± 0.4	1.1 ± 0.4	0.065
Triglycerides (mmol/l)	1.5 (1.1–2.1)	1.7 (1.2–2.4)	<0.05
Creatinine (μmol/l)	82 (72–95)	90 (72–110)	<0.05
Glucose (mmol/l)	6.8 (6.0–7.8)	9.9 (7.5–13.3)	<0.001
HbA1c (%)	5.7 (5.5–5.9)	6.6 (6.2–7.8)	<0.001
HbA1c (mmol/mol)	39 (37–41)	49 (44–62)	<0.001
Cardiovascular risk SCORE	22.6	36.5	<0.001
History of hypertension (%)	31.4	70.7	<0.001
History of hypercholesterolemia (%)	20.7	51.6	<0.001
History of AF (%)	1.7	6.5	<0.05
No monitoring (%)	55.0	n.a.	
Type of MI			0.389
STEMI (%)	52.7	51.9	
NSTEMI (%)	47.3	48.1	
Intervention			0.306
Conservative (%)	26.7	31.2	
PCI (%)	67.1	65.0	
CABG (%)	6.2	3.8	