International Journal of Cardiology xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Physician specialty and long-term survival after myocardial infarction — A study including all German statutory health insured patients

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ARTICLE INFO

Article history:
Received 21 June 2017
Received in revised form 25 September 2017
Accepted 13 October 2017
Available online xxxx

Keywords:
Myocardial infarction
Ambulatory care
Cardiologist
Mortality
Medical claims data

ABSTRACT

Background: With a mortality rate above European average, myocardial infarction (MI) is the second most common cause of death in Germany. Data about post-MI ambulatory care and mortality is scarce. We examined the association between ambulatory treating physicians' specialty and the mortality of post-MI patients.
Methods: Medical claims data of all 17 German regional Associations of Statutory Health Insurance physicians were analyzed, which cover approximately 90% of the German population. Patients with a new diagnosis of a MI in 2011 were divided into treatment groups with and without ambulant cardiology care within the first year after MI diagnosis. Propensity-score matching based on socio-demographic and clinical variables was performed to achieve comparability between groups. The 18-month mortality rate was derived employing a validated method.
Results: 158,494 patients with a new diagnosis of MI had received post-MI ambulatory care in 2011. Half of them (51%) had at least one ambulatory contact with a cardiologist within the first year. During a follow-up of 18 months, the mortality rate before and after propensity-score matching was 19% and 14% in patients without cardiology care and 6%, respectively, in patients with cardiology care ($\chi^2 = 666.7$; $P < 0.000$ after propensity adjustment). Patients who only saw a cardiologist and had no additional contact to an ambulant general practitioner (GP)/internist within the first year did not have increased survival rates.
Conclusions: Outpatient follow-up care by a cardiologist in combination with consultations of GP/internists within the first year may be of importance for the prognosis of MI patients.

1. Introduction

Myocardial infarction (MI) is the second most common cause of death in Germany [1]. In recent years, MI incidence and mortality rates have declined [2–6] due to combined effects of prevention, progress in therapy and improved guideline-based care of patients [7]. Still, the German MI mortality rates are above the European Union's average [8].

After a MI, 24% of patients die immediately or on the way to the hospital [9] and 9% of those who get to the hospital alive die in-hospital [10]. About 20% of patients aged 75 and older die within one year after being discharged from hospital in Germany [11]. International studies report mortality rates of around 11% within one year, 21% within three years and 33% within five years after hospital discharge [12,13].

In-hospital clinical management as well as a variety of biological, socio-economic and behavioral patient characteristics have been associated with differences in the short and longer-term mortality for MI [14–17]. European guidelines for the long-term management of post-MI patients focus on the rigorous control of cardiac risk factors [18,19].

Less attention has been paid to the role of the physicians who provide care after a MI. Studies have shown that the treating physicians' specialty in-hospital might play an important role for the prognosis of a patient. Patients who were treated by cardiologists had lower mortality rates in comparison to patients who were treated by other internists or general practitioners (GP) [20–24].

However, the treating physician's specialty might also be important in the post-MI aftercare in the outpatient sector. In an US-American study, Ayanian et al. investigated 35,520 elderly Medicare patients (aged 65 to 84 year) after hospitalization for MI in 1994 or 1995. They showed that patients who had visited an ambulant cardiologist had a significantly reduced two year mortality compared to patients who only consulted an internist or GP [25]. Most other studies reporting on differences between generalist and specialist care have been published in the United States and examined the in-hospital time and short-term

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https://doi.org/10.1016/j.ijcard.2017.10.048
0167-5273/

survival of patients. A possible association of the specialty of the ambulatory treating physician with long-term mortality has not been studied recently, and to our knowledge, no such analysis has been performed in Europe. Germany in particular has a healthcare system that offers a unique opportunity for the analysis of specialist care impact, since it provides access to GP care and specialist care for all insured patients, regardless of their insurance company, age, employment or socio-economic situation.

We used medical claims data of all patients with statutory health insurance (SHI) in Germany (90% of the population) to assess the number of patients post MI who received care in the outpatient sector in 2011. Controlling for potential differences in comorbidities and smoking, we tested whether patients who had at least one ambulatory care visit to a cardiologist had different 18-month survival rates in comparison to patients who did not receive ambulatory care by a cardiologist at all.

2. Methods

2.1. Patient population

Analyses were carried out using Germany-wide ambulatory medical claims data [26] of the National Association of SHI Physicians for the period of 2009 until June 2015. Data was available for all persons insured in a SHI in 2011, which applies to about 90% of the population in Germany, approximately 70 million persons. The claims data contains individual pseudonymised information on the patient (age, gender, regional-code), diseases as encoded diagnoses (International Classification of Diseases (ICD-10)), and information about the ambulatory healthcare (participating physician, medical indication, invoiced procedures, treatment costs) on a quarterly basis.

Individuals were included in the study if they were given a new diagnosis of MI in 2011 (ICD-10: I21, I22) coded as 'confirmed' or 'state after' from an ambulatory physician. Patients were excluded from the study if they had earlier been diagnosed with a MI, if no or no plausible information was available for age, gender, or type of district and if they had not had contact to an ambulant GP, internist or cardiologist within the first year after the diagnosis of MI. For the main analysis of the follow-up care within the first year, we divided patients into two groups: 1) patients without ambulatory cardiology care and 2) patients who at least once consulted an ambulant cardiologist.

Patients were followed from the quarter in 2011 of their first ambulatory diagnosis of MI until the end of June 2015. For each eligible patient, information was extracted from the database on demographics (age, gender, regional-code by the time of their first ambulatory MI diagnosis), secondary diagnoses (ICD-10 encoded), ambulatory medical treatments and the number of visits to different outpatient physicians.

Based on the regional-code, the patients were assigned to different types of districts: big cities, urban counties, rural counties (showing densification), and sparsely populated rural counties [27]. In our analysis we included all comorbidities and diagnoses that were identified from literature as being independent risk factors for a higher mortality rate. Further diagnoses of interest were those showing a significant difference between the two patient groups one year before the diagnosis of MI. The diagnoses had to be coded as 'confirmed' or 'state after' from any ambulatory physician within six quarters preceding or subsequent to the first diagnosis of MI.

Individual patient baseline morbidity level at baseline was assessed using the Charlson Comorbidity Index (CCI) [28,29]. The CCI is a widely used measure of comorbidity, developed to predict 1-year mortality in a cohort of medical inpatients [28]. An overall score with a maximum of 29 points is calculated from a list of 17 conditions, each of which has been allocated a weight between one and six based upon its adjusted relative risk of 1-year mortality [28,29]. The individual scores were calculated on the basis of whether a particular condition was present as 'confirmed' within the preceding six quarters before the initial MI diagnosis. See the Supplemental Material for a list of specific ICD-10 codes that have been used. As MI was the condition of interest in this study, it was not included in the calculation of the CCI score.

2.2. Identification of deceased patients

Since the medical claims data do not contain information on the death of a patient, an identification method was developed and validated using an existing German insurance sample. This insurance sample is a subsample of 20% of insured persons based on medical claims data and is representative for all insured persons in SHI in Germany [30]. It is validated and crosschecked by the insurance companies.

Within the insurance sample, the physicians' treatments and diagnoses are recorded as well as the insured person's death [31]. Therefore, this sample provides the basic information to verify the validity of our methods to identify deceased persons in the larger medical claims database.

To identify the death of a patient in the data used for analysis, the following steps were taken: patients with MI in 2011 were identified and two observation periods were defined. The first period is the ambulant post-MI-period in 2011, beginning with the quarter of the MI diagnosis. The second period is a control-period in which the survival status of each patient is assessed, covering the years 2012–2013. If a patient did not have at least one ambulatory care contact to any ambulatory physician during the two year control-period, it was assumed that he or she was deceased during the post-MI-period in 2011.

This procedure was then applied to the data of the insurance sample. After applying of the methodology with a two year control period to check whether the patient is still alive, followed by matching it with the actual deceased variable which is available in the insurance sample, 99.3% of the patients were classified correctly and 0.7% of the patients were classified incorrectly.

This validated deceased-methodology was subsequently applied to the patients with MI in the full data set. Since the medical claims data are available until June 2015, both observation periods were extended. The post-MI-period was extended up to six quarters (18 months), beginning with the quarter of the MI diagnosis. This observation period has the same length for every patient to be able to compare them with each other. The ensuing control period to check the survival of patients was extended to a minimum of two years, ending for all patients with the end of June 2015.

To classify a patient as 'survived' in the 18-month 'ambulant post-MI-period', the patient had to have at least one ambulatory visit to any SHI physician during the individual subsequent two up to three year control period. If this was not the case, the patient was marked as 'deceased'. Based on the described results of the validation of this method within the insurance sample as well as the extended observation period, it is assumed that the misclassification bias is below 1%.

2.3. Statistical analyses

We used nearest neighbor propensity-score matching to ensure that the two patient-groups, with and without cardiology care, were comparable in terms of patient characteristics. The propensity-score was estimated by the use of all listed variables and the CCI score in Table 1 [32–34]. Based on the calculated score, every patient of the group with cardiology care was matched to the closest patient of the group without cardiology care.

Furthermore, the propensity-score's tolerable deviation of each match was defined in advance with a Caliper ("maximum distance"), therefore consequently excluding bad matches with high differences. The Caliper was set at $c = 0.00001 * \text{propensity-score's standard deviation}$, which reduced the difference between the groups by >95% [35].

Continuous variables are presented as mean values and standard deviation (SD); categorical variables as frequency counts and percentages. We used χ^2 test in the unmatched and McNemar's test for paired data in the matched data to evaluate the differences in 18-month-mortality among the compared groups. A bilateral probability threshold of 0.05 was used to determine statistical significance. After patient matching for each gender and type of district we calculated the relative risk (RR) and RR reduction in mortality. All statistical analyses were performed using the statistics software R, matching was performed using the packages "MatchIt" [36] and "RItools" [37].

3. Results

3.1. Baseline characteristics

170,806 patients with a new diagnosis of MI in 2011 were enrolled in the data analysis, 12,312 patients were excluded after applying the exclusion criteria (Fig. 1). In total 158,494 patients were included in the main analysis. Baseline characteristics for the study sample, divided into the groups with and without contact to a cardiologist within the first year are presented in Table 1.

The mean age of all patients was 69 years (±13.4), 63% were men. About half of the patients (51%) had at least one contact with an ambulant cardiologist during the first year; slightly more patients in the former western states of Germany (52%) compared to the former eastern states (49%). Further aspects of analysis did not show relevant differences regarding results from former eastern or western parts of Germany. More men consulted a cardiologist (55%) in comparison to women (44%). The proportion of patients who received cardiology care was highest in big cities with a total of 55% (men: 59% vs. women: 48%), decreased with the level of urbanization to 52% (57% vs. 45%) in urban counties, to 47% (51% vs. 40%) in rural counties, to the lowest proportion of 46% (50% vs. 39%) in sparsely populated rural counties.

3.2. 18-month mortality

A total of 12% died within the 18-month follow-up (men: 11% vs. women: 15%). The proportion of deceased patients during the 18-month follow-up period was three times higher in the group without cardiology care (19%) than in the group with cardiology care (6%).

The patient groups with and without cardiology care also differed in the proportion of comorbidities and other diagnoses and the CCI score

Please cite this article as: M. Radzimanowski, et al., Physician specialty and long-term survival after myocardial infarction — A study including all German statutory health insured..., Int J Cardiol (2017), https://doi.org/10.1016/j.ijcard.2017.10.048