The impact of geographical distances to coronary angiography laboratories on the patient evaluation pathways in patients with suspected coronary artery disease. Results from a population-based study in Hungary

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Abstract

Introduction: Coronary artery disease (CAD) has been a leading cause of death in the western world for the last few decades, despite significant improvements in treatment and management. Diagnostic algorithms for the evaluation of patients with suspected CAD are based on available guidelines.

Aim: To evaluate the impact of geographical distances to coronary angiography laboratories on the patient evaluation pathways in patients with suspected CAD, from a population-based study in Hungary.

Material and methods: Depersonalised data of 29,202 patients identified by their pseudo-social security number were analysed. All patients underwent coronary angiography as an initial direct invasive investigation (DI) following an at least half-year-long stable period between 1 January 2004 and 31 December 2008.

Results: One hundred and thirty-five dominant primary cardiology centres (PCC) have been identified, from which 85 proved to have sample size more than 100 DIs in tertiary cardiology centres (TCC). The frequency of DIs showed a close correlation with PCC-TCC distances ($r = -0.44$, $p < 0.001$). A negative correlation could be demonstrated between the age of patients and PCC-TCC distances ($r = -0.45$, $p < 0.001$). Without significant change in the absolute mortality, the relative mortality increased with the increase in PCC-TCC distance ($r = 0.25$, $p < 0.05$).

Conclusions: The PCC-TCC distance has an important effect on patient pathways in subjects with suspected CAD.

Key words: administrative databases, coronary artery disease, coronary angiography, distance, invasive care.

Introduction

Coronary artery disease (CAD) has been a leading cause of death in the western world for the last few decades, despite significant improvements in treatment and management [1]. Diagnostic algorithms for the evaluation of patients with suspected CAD are based on available guidelines [2]. However, it is known that greater distance to health care facilities is associated with poorer health care service utilisation [1]. Recently, several studies have demonstrated that a relationship exists between geographic indicators and treatments in CAD patients [3]. Recently, a new method has been introduced to depict characteristics of patient selection for primary coronary angiography based on population-based data from Hungary [2, 4].

Aim

The present study was designed to evaluate the impact of geographical distances to coronary angiography laboratories on the patient evaluation pathways in patients with suspected CAD.

Material and methods

Patient population

From 513,806 subjects assessed for chest pain, data of 29,202 patients identified by their pseudo-social se-

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curity number were analysed based on the database of the National Institute for Quality and Organisational Development in Healthcare and Medicines (GyEMSzI). All these patients underwent coronary angiography as an initial direct invasive investigation (DI) following an at least half-year-long stable period between 1.01.2004 and 31.12.2008 due to anamnestic chest pain. Patients with initial investigation other than DI coronary angiography are summarised in Figure 1. Patients with acute myocardial infarction (AMI) were excluded from the evaluations.

Data collection and analysis

Data collection and analysis have been demonstrated in more detail previously [2, 4]. Briefly, we created a coded event list for each patient using the International Classification of Diseases (ICD) codes and International Classification of Procedures in Medicine (ICPM) codes of the source database. We also created a death event from each death case in the death registry. In the second step, we merged common event sequences into a single event, based on a set of common-sense rules describing our clinical coding practice. For example, a 'stress electrocardiography' event followed by a 'SPECT' event on the same day was replaced by a single 'stress SPECT' event. A similar merge was performed to handle duplicated events of the two-day SPECT protocol. Then we selected patients with stable conditions as those having no diagnosis of AMI and having coronary angiography as a DI after a 6-month-long event-free period.

Since we had access to the postal codes (ZIP) of the patients, we performed a spatial analysis of patient pathways. For each patient, we defined her/his primary care provider as the provider of her/his first stress electrocardiography in the observation period. Our ZIP area clustering procedure then identified 136 primary cardiology centres (PCCs) based on the care records of patients living in the area supplied primarily by the centre. In order to limit the number of possible providers, we considered the various departments of a large institution (e.g. a municipal hospital) as the same. In a recently published paper, statistical analysis revealed one centre with an outlier high value for mortality; therefore, this centre was deleted from further analysis [4]. In a similar procedure we identified 17 dominant tertiary cardiology centres (TCCs) nationwide. The TCC is the centre where most patients received DI for a given PCC.

Results

Description of primary cardiology centres and tertiary cardiology centres

One hundred and thirty-five dominant PCCs have been analysed, from which 84 proved to have sample size more than 100 DIs in TCCs. These centres covered 88.1% of the population of Hungary, delivering 90.1% of all performed DIs. The average population size for these 84 cen-

tres was 105,234 ±75,917 inhabitants per centre ranging from 22,881 to 498,328. The frequency of DIs was 66.6 ±25.3 per 100,000 inhabitants (range: 24.8 to 151.3).

Distances between primary cardiology centres and tertiary cardiology centres

The mean distance on public roads used by ambulance services between a PCC and its TCC was 49.2 ±46.2 km.

Patients and their mortality

The mean age of the patients was 62.2 ±2.1 years, while the 1-year mortality was 6.1 ±2.0%. The absolute mortality proved to be between 1.2% and 11.2%, while the age- and gender-adjusted relative mortality ranged between 24% and 207%.

Correlations

The frequency of DIs showed a close correlation with PCC-TCC distances ($r = -0.44$, $p < 0.001$) (Figure 2). Also, a negative correlation could be demonstrated between the age of patients and geographical distances between PCCs and TCCs ($r = -0.45$, $p < 0.001$) (Figure 3). Without a significant change in the absolute mortality, relative mortality increased in parallel with distances between PCCs and TCCs ($r = 0.25$, $p < 0.05$) (Figure 4).

Discussion

To the best of the authors' knowledge, this is the first time when the effect of PCC-TCC distance on patient evaluation pathways could be demonstrated from a population-based study in Hungary. Correlation was found between the distance of primary and tertiary cardiolog-
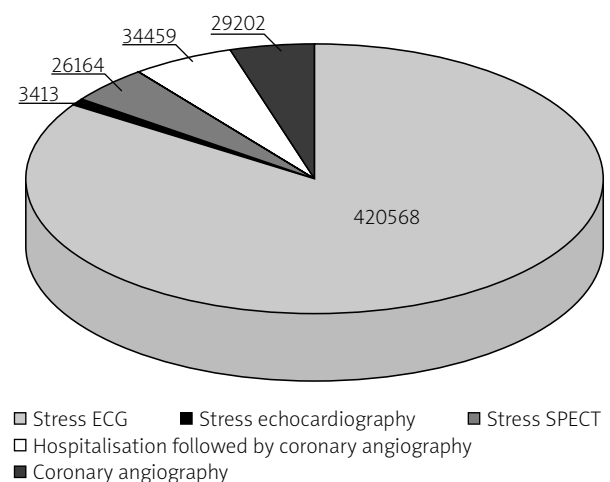

☐ Stress ECG   ■ Stress echocardiography   ▨ Stress SPECT
☐ Hospitalisation followed by coronary angiography
■ Coronary angiography

Figure 1. Initial direct examinations following an at least half-year-long stable period between 1 January 2004 and 31 December 2008 due to anamnestic chest pain, including direct coronary angiography
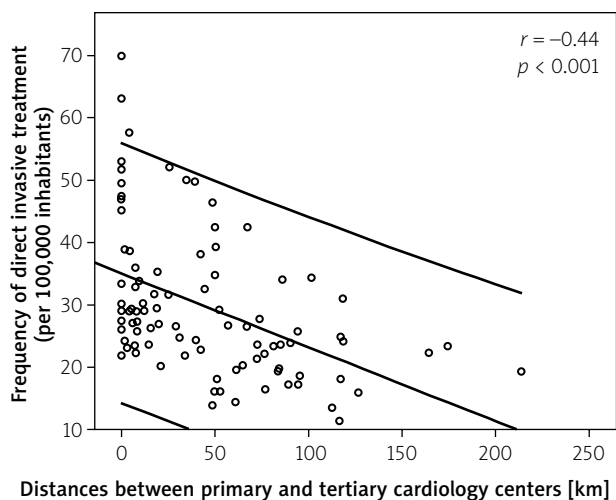
Figure 2. Correlations between frequency of direct invasive treatments and distances between primary and tertiary cardiology centres
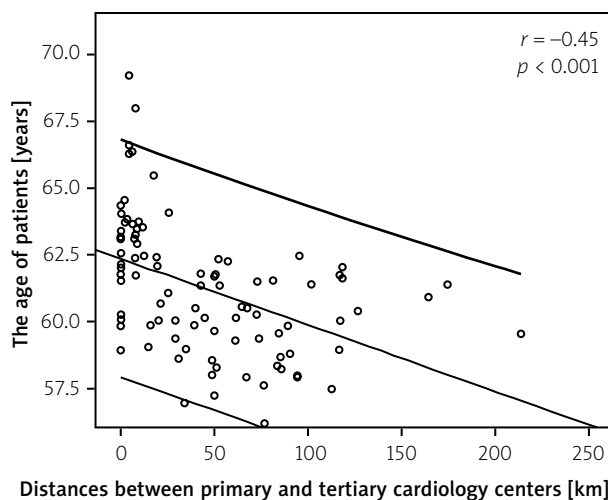

Figure 3. Correlations between age of patients and distances between primary and tertiary cardiology centres
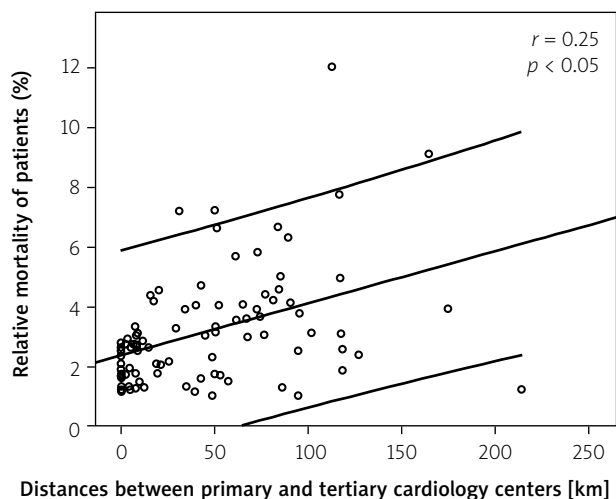

Figure 4. Correlations between relative mortality of patients and distances between primary and tertiary cardiology centres

ical centres and the frequency of direct invasive investigations. It could also be demonstrated that a negative correlation exists between the age of patients and geographical distance. Relative mortality also increased with larger distance.

Recently, several papers investigated the impact of geographic locations on examinations and treatments of patients with suspected CAD. Morris *et al.* demonstrated that there were major inequalities in the probability of undergoing coronary revascularisation between British men according to socioeconomic status, age, and geographic location, in the 1990s [5]. They found that increasing age, lower social status, and residence outside southern England are related to a diminished likelihood of revascularisation. Two measures that were most

strongly and independently predictive of undergoing revascularisation were car ownership and housing status. Gregory *et al.* confirmed that the distance from patients' residence to hospitals with cardiac revascularisation services was inversely related to utilisation of these services after AMI in a study from the USA. The closer the services, the higher the use of percutaneous coronary angioplasty (PCI) (up to 3-times higher) and coronary-artery bypass graft operation (CABG) (up to 2-times higher) [3]. Availability of cardiac revascularisation services at the hospital nearest to the patient's residence was also associated with increased utilisation. A study with AMI patients found that those living ≤ 2.5 miles from a hospital with catheterisation laboratory or revascularisation services were more likely to have received revascularisation procedures than those living > 2.5 miles away [6]. However, rates of CABG utilisation were less related to distance from CABG services in Canada [7, 8]. Our study results are in agreement with these findings. However, correlations between geographic proximity of DI and the utilisation of DI were found in stable patients with suspected CAD.

Sekhri *et al.* aimed to determine whether access to rapid access chest pain clinics of people with recent onset symptoms is equitable by age, socioeconomic status, ethnicity, and gender, according to need. As expected there was evidence of underutilisation of chest pain clinics by older people and those from lower socioeconomic status [9]. In the recent study negative correlation could be demonstrated between the age of patients and geographical distance, suggesting that for larger distances older stable patients are not commonly selected for DI.

Several studies are available investigating the relationship between geographic indicators and other cardiac treatments, e.g. cardiac rehabilitation (CR) utilisation

[10–12]. In a study, it was suggested that physicians may be taking geography into consideration when referring patients to CR. Empirical consideration also reveals that patients are significantly less likely to enrol in CR if they have to drive 60 min or more to the closest program [10]. Overall, 52.9% of the identified studies reported a significant negative relationship between geographic indicators and CR utilisation [11]. This association could be demonstrated in the USA and Canada, but the relationship was weaker in Great Britain where the population is denser and public transport is more readily available.

One of the main advantages of the present study is that results are from population-based evaluations where centres covered 88.1% of the total population of Hungary with 10 million inhabitants, delivering 90.1% of all performed direct invasive investigations (DIs). This opportunity allows deeper insights into the mechanism of the working healthcare system in an East European country. Moreover, stable patients with suspected CAD were examined, while previously mostly AMI patients were evaluated. However, one of the limitations of this study is that the present analysis does not account for the follow-up treatment of the patients evaluated invasively.

Conclusions

The PCC-TCC distance has an important effect on patient pathways in subjects with suspected CAD.

Acknowledgments

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