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## Original research article

# Geographic variation in the access to heart transplantation in the Czech Republic



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## ABSTRACT

**Background:** Heart transplantation (HTx) is the last resort therapeutic option in management of end-stage heart failure (HF). Geographic variation in incidence of HTx may disclose regional bias in the access to health care. The purpose of the study was to evaluate regional distribution of HTx in the Czech Republic.

**Methods:** We retrospectively analyzed data from all patients who underwent HTx in the Czech Republic between 1.1.2008 and 30.9.2013 and determined the incidence of HTx in all counties (“okresy”) and higher administrative regions (“kraje”). In addition, we determined whether such regional incidence of HTx was related to geographical, demographic, socio-economic factors or regional variation in coronary artery disease (CAD) or diabetes mellitus (DM) prevalence.

**Results:** Within the period above, 496 HTx were performed in the only two national transplant centers (8.211 per year and million inhabitants). Their regional incidence ranged between 4.4 and 12.2 per year and million inhabitants without a significant difference.

On the level of counties, difference in HTx incidence was statistically significant ( $p < 0.0001$ ) with six counties out of seventy-seven being responsible for uneven distribution. The incidence of HTx was not related to the distance to the nearest HTx center ( $p = 0.09$  for counties,  $p = 0.28$  for regions) and was similar in regions with and without a complex cardiovascular center ( $7.77 \pm 2.17$  vs.  $7.94 \pm 1.56$ ,  $p = 0.87$  per year and million inhabitants). Interestingly, the incidence of HTx was unrelated to the number of hospitalizations for CAD in regions ( $p = 0.78$ ), number of patients with DM in regions ( $p = 0.10$ ), percentage of males both in regions ( $p = 0.32$ ) and counties ( $p = 0.76$ ) and age of population ( $p = 0.79$  for regions,  $p = 0.42$  for counties). HTx incidence also did not correlate with average salary in regions ( $p = 0.30$ ) and unemployment rate both in counties ( $p = 0.76$ ) and regions ( $p = 0.89$ ).

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**Conclusion:** Regional incidence of HTx was found evenly spread throughout regions, indicating no geographic restrictions in access to this advanced therapy in the Czech Republic. The variation in regional HTx incidence was unrelated to average regional age, gender, incidence of CAD or DM, income or unemployment rate.

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## Introduction

Heart transplantation (HTx) is the last resort therapeutic option in management of end-stage heart failure (HF) [1]. One-year survival after HTx is approximately 90% [2] and the same proportion of subjects has no limitation in activity up to 5 years after the procedure [3]. Since the HTx is a procedure with enormous requirements on organization and recourses, it is usually offered by a restricted number of heart centers. In the same time, HTx is well documented and traceable procedure which can be used as a surrogate marker of availability of specialized medical care. It is unknown whether there is any referral bias in the Czech Republic, making HTx less available in certain regions due to geographic, socioeconomic or epidemiologic reasons. The purpose of this study was to investigate whether regional incidence of HTx is evenly distributed within the country or whether there is significant inhomogeneity, speaking in favor of referral bias.

## Methods

### Patients

We analyzed all HTx procedures that were performed in the entire Czech Republic between 1.1.2008 and 30.9.2013. Postal code ("PSC") of permanent residential address of the patients at the time of HTx was used to evaluate regional incidence of HTx in the whole country and its higher administrative regions ("kraje") or in all counties ("okresy"). The distance of the respective county and/or region to the nearest complex cardiovascular center and nearest HTx center was also assessed. For the sake of analysis, the number of inhabitants of all counties and regions was considered constant throughout the respective time period and ascertained to 31st December 2011. Demographic data (including average income in regions or unemployment rate) were obtained online using Czech Statistical Office Public Database (<http://vdb.czso.cz>). The data about number of CAD hospitalizations and DM prevalence were collected from the Institute of Health Information and Statistics of the Czech Republic ([www.uzis.cz](http://www.uzis.cz)). Data about CAD hospitalizations pertain to 2010, data about DM prevalence to 2012 (not available annually).

### Statistical analysis

Data were analyzed using JMP 10.0 (SAS Institute Inc.). Differences between two groups were tested with t-test. HTx distribution on the level of counties and regions, distribution of hospitalizations due to CAD and prevalence of diabetes

mellitus were analyzed with chi-square test. The relation between HTx incidence and analyzed factors (hospitalizations for CAD, DM prevalence, age, gender, average salary, unemployment rate) was analyzed using linear regression. A  $p$ -value  $< 0.05$  was considered statistically significant.

## Results

### Regional distribution of HTx recipients in the Czech Republic

The Czech Republic has population of 10 505 445 inhabitants (at 31st December 2011) and divides into 14 administrative regions and 77 counties. Complex cardiovascular center is available only in 7 administrative regions. There are two HTx cardiovascular centers in the Czech Republic. Institute for Clinical and Experimental Medicine in Prague is in the western part of the country and Center of cardiovascular surgery and transplantation in Brno covers the eastern regions.

Between 1.1.2008 and 30.9.2013, 496 HTx procedures were performed. This corresponds to the average of 8.211 HTx procedures per year and million inhabitants. Twenty patients were not transplanted in the nearest HTx center. Within the above mentioned period, all counties and regions had at least one patient undergoing HTx.

Among the regions, the incidence of HTx ranged between 4.4 and 11.2 per year and million inhabitants (mean 7.9, SD 1.8, Fig. 1a). The difference between regions was not statistically significant. The incidence of HTx in all regions is shown in Fig. 2. Among counties, HTx incidence ranged between 1.2 and 20.9 per year and million inhabitants (median 7.4, IQRs 5.0–10.2). On the level of counties, difference in HTx incidence was statistically significant ( $p < 0.001$ , Fig. 1b). Counties with significantly different incidence of HTx were as follows: Praha-zapad (20.9), Rokycany (18.3), Jeseník (17.2), Zlín (16.2), Beroun (16.2) and Prostějov (15.9 per year and million inhabitants, respectively). The map of HTx distribution on the level of counties is shown in Fig. 3.

### Distance to the nearest HTx center

There was no significant relationship between the distance of the county or region of residence to the nearest HTx center and HTx incidence ( $r^2 = 0.09$ ,  $p = 0.28$  and  $r^2 = 0.04$ ,  $p = 0.09$  for regions and counties, respectively, Fig. 4a). Similarly, when counties were divided to those with the HTx incidence above and below the overall average of the Czech Republic (8.211 per year per million inhabitants) counties with the superior HTx incidence were not significantly closer to HTx center than those with the inferior incidence ( $91.6 \pm 50.7$  vs.  $107.6 \pm 39.8$  km,  $p = 0.13$ ).

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