History
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Utilization of healthcare services in acute myocardial infarction and the risk of out-of-hospital cardiac death

COVID-19 represented a significant challenge to cardiovascular (CV) medicine research, treatment, prevention, and, to a considerable extent, case management. The global pandemic viral infection increased the risk of thrombotic events, both venous and arterial, in a huge number of patients.[1] Those with CV disease were more susceptible to COVID-19 infection and had a higher mortality rate.[2] Gravely restricted accessibility to healthcare services[3] on the one hand and underutilization[4] on the other posed a significant risk during COVID, particularly regarding prevention and treatment of major CV events. Acute myocardial infarction (AMI), especially ST elevations MI (STEMI), represents the riskiest and the most challenging in terms of access to care.[5] Lack of emergency medical care has disastrous consequences for those affected, both in immediate death and death from subsequent heart failure. Therefore, we examined the impact of the pandemic on the relationship between in-hospital care utilization for AMI (IH-AMI) and out-of-hospital CV death (OH-CVD). Due to legal obligations, the availability of comprehensive data from information systems and all-comers registries has enabled accurate analysis on the national level. The data was collected from the National Health Information System, namely the National Registry of Reimbursed Health Services, National Registry of Cardiovascular Surgery and Interventions, and Registry of deaths in the Czech Republic, combined with data from the Information System of Infectious Diseases for COVID-19 data. We compared the pandemic (2020-2021) with the four years (2016-2019) before the pandemic. The period was chosen to utilize standardized registry data. Cardiovascular death was defined according to the International Classification of Diseases; the codes I00-I99 were used. Standard descriptive statistics were used in the analysis, *i.e.*, absolute and relative frequencies of patients and standardization per 100,000 of the population. Differences in incidence rates between compared time periods were described using incidence rate ratios (RR), 95% confidence intervals (CI), and statistical significance. Relationships between epidemiological characteristics aggregated in the months of the evaluated period were analyzed using the Pearson correlation coefficient and its statistical significance. The month aggregation was used to achieve stable results based on sufficient sample size in each time period; for specialized analyses, aggregation into periods with and without lockdown was applied too. The data for analysis were preprocessed using the Vertica and MS SQL databases with DBeaver version 22.1.0 (DBeaver, New York, NY, USA); analyses were computed using SPSS 27.0.0.0. (IBM, Armonk, NY, USA). The population for the analysis consisted of 64,291 AMI cases and 256,139 cases of OH-all cause deaths. Hospitalizations for AMI (in-hospital AMI [IH-AMI]) expressed as numbers per 100,000 population have had a long-term stable trend: 104.8 in 2016, 104.5 in 2017, 99.3 in 2018, and 102.9 in 2019. In the pandemic (*vs.* 2016-2019), there was a significant reduction in IH-AMI. For acute IH-STEMI, the incidence RR (95% CI) was 0.956 (0.925; 0.987) in 2020 (43.0 per 100,000 population in 2020 *vs.* 45.0 in 2016-2019) and 0.905 (0.876; 0.936) in the second COVID-19 year (40.7 cases). The trend was the same for NSTEMI with an RR of 0.943 (0.911; 0.976) in 2020 and 0.911 (0.880; 0.943) in 2021. In absolute numbers, there were 38.1 (2020) and 36.8 (2021) *vs.* 40.4 IH-NSTEMI (2016-2019), all per 100,000 population. The drop represented 0.18 cases (2020) and 0.17 (2021) of IH-STEMI (*per* 100,000 population) for every increase of 1,000 COVID-19 cases (Figure 1A). Change in the number of IH-STEMI cases was different in the first compared to the second pandemic year, *i.e.*, the number of infected was substantially higher in the second year. The correlation between the monthly numbers of COVID-19 and the change in IH-STEMI was significant in the second year (r=-0.790, P=0.003). In the first year, the decline in IH-STEMI was primarily driven by the national lockdown, where the decrease was 0.41 cases per 100,000 population ($P_{(t\text{-test})}$=0.049 for the comparison of monthly data between the lockdown and non-lockdown period). In addition to IH-AMI, the number of all CV disease-related hospitalizations declined by 375 cases per 100,000 population in 2020 and 400 in 2021. Moreover, during the 2020 lockdown year, there was an alarming decline in in-person outpatient clinic visits to internists and cardiologists (814 visits per 100,000 population). Out-of-hospital CV death rates (OH-CVD) increased and were opposite to the IH-STEMI trend. The rates of OH-CVD, which had been stable in the prepandemic years (191 in 2017, 196 in 2018, 193 in 2019 per 100,000 population), increased significantly in the COVID-19 period compared to the mean OH-CVD in 2016-2019; with an incidence RR of 1.193 (1.176; 1.210) in the first and 1.121 (1.105; 1.378) in the second year. In absolute numbers, there were 226 cases (2020) and 213 cases (2021), both per 100,000 population. Analysis of the change in OH-CVD in relation to the change in IH-STEMI compared to the reference period (2016-2019) showed an increase of 3.3 cases (2020) and 2.7 cases (2021) of OH-CVD for every decrease of 1 hospitalization for acute STEMI (both per 100,000 population) (Figure 1B). Further analysis showed that a decrease of 1 hospitalization for CV disease (other than AMI) was associated with an increase of 0.05 cases (2020) and 0.06 cases (2021) of OH-CVD (both per 100,000 population) (Figure 1C). Moreover, a decrease of 1,000 in-person outpatient visits to internal medicine or cardiology specialists was accompanied by an increase of 2.0 cases (2020) and 4.3 (2021) cases of OH-CVD (both per 100,000 population) (Figure 1D). COVID-19 significantly reduced the number of IH-AMI while substantially increasing the incidence of OH-CVD. These changes were directly impacted by the number of infected and the lockdown period, and this correlation

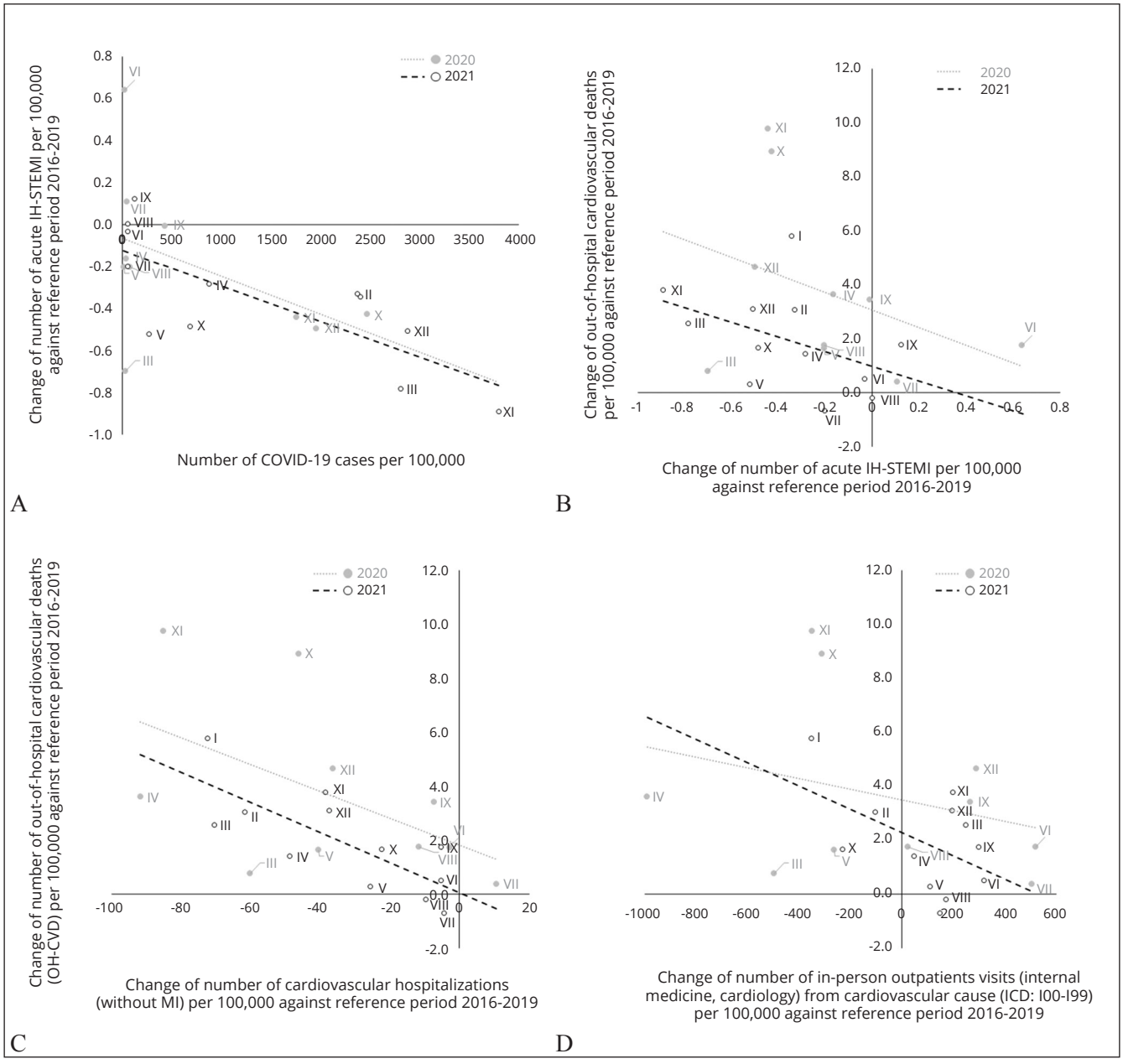

Figure 1.—Analyses of changes associated with the COVID-19 pandemic: A) change in number of acute STEMI per 100,000 population relative to the 2016-2019 reference period *vs.* the number of COVID-19 per 100,000 population; B) change in the number of out-of-hospital cardiovascular deaths (OH-CVD) per 100,000 population *vs.* change in the number of acute IH-STEMI *per* 100,000 population (relative to the 2016-2019 reference period); C) change in the number of OH-CVD per 100,000 population *vs.* the change in the number of cardiovascular hospitalizations (without MI) per 100,000 population (relative to the 2016-2019 reference period); D) change in the number of OH-CVD per 100,000 population *vs.* the change in the number of in-person outpatients visits (internal medicine, cardiology) due to a cardiovascular cause (ICD: I00-I99) per 100,000 population (relative to the 2016-2019 reference period).

persisted unchanged during the two-year pandemic period. What has the pandemic taught us about managing and treating cardiovascular disease? In situations that require social distancing and lead to increased demands on healthcare and cause system underutilization, it is imperative to focus the efforts of management, researchers, and clinicians on adopting measures that prioritize medical care to the most at-risk patients, for whom time to treatment is critical to prognosis. Our analysis showed that any decrease in the hospital-

ization of patients with AMI, especially STEMI, can substantially increase OH-CVD.

Zuzana MOTOVSKA [1] *, Ota HLINOMAZ [2], Milan HROMADKA [3], Jan MROZEK [4], Jan PRECEK [5], Petr KALA [6], Tamilla MUZAFAROVA [1], Jiri KETTNER [7], Jan MATEJKA [8], Josef BIS [9], Pavel CERVINKA [10], Pavol TOMASOV [11], Anna KLECHOVA [12], Ondrej SANCA [12, 13], Jiri JARKOVSKY [12, 13]

[1]Cardiocenter, Third Faculty of Medicine, University Hospital Kralovske Vinohrady, Charles University, Prague, Czech Republic; [2]First Department of Internal Medicine and Cardioangiology, International Clinical Research Center, Faculty of Medicine, St. Anne's University Hospital, Masaryk University, Brno, Czech Republic; [3]Department of Cardiology, Faculty of Medicine in Pilsen, University Hospital of Pilsen, Charles University, Pilsen, Czech Republic; [4]Department Cardiovascular Surgery, University Hospital of Ostrava, Ostrava, Czech Republic; [5]Department of Internal Medicine I and Cardiology, Faculty of Medicine and Dentistry, University Hospital of Olomouc, Palacky University, Olomouc, Czech Republic; [6]Department of Internal Medicine and Cardiology, Faculty of Medicine, University Hospital of Brno, Masaryk University, Brno, Czech Republic; [7]Department of Cardiology, Institute of Clinical and Experimental Cardiology, Prague, Czech Republic; [8]Department of Cardiology, Hospital of Pardubice, Pardubice, Czech Republic; [9]Department of Cardiovascular Medicine I, University Hospital of Hradec Kralove, Hradec Kralove, Czech Republic; [10]Department of Cardiology, Krajska Zdravotni A.S., Masaryk Hospital, Jan Evangelista Purkyne University, Usti nad Labem, Czech Republic; [11]Cardiocenter, Liberec Regional Hospital, Liberec, Czech Republic; [12]Institute of Health Information and Statistics of the Czech Republic, Prague, Czech Republic; [13]Institute of Biostatistics and Analyses, Faculty of Medicine, Masaryk University, Brno, Czech Republic

*Corresponding author: Zuzana Motovska, Cardiocenter, Third Faculty of Medicine, University Hospital Kralovske Vinohrady, Charles University, Prague, Czech Republic. E-mail: zuzana.motovska@lf3.cuni.cz

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Conflicts of interest
The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Authors' contributions
Zuzana Motovska has given substantial contributions to study conception, data interpretation, and manuscript writing, Ota Hlinomaz to data acquisition, manuscript critical revision for important intellectual content, Milan Hromadka to data acquisition and manuscript critical revision for important intellectual content, Ondrej Sanca to data analysis and manuscript critical revision for important intellectual content, Jiri Jarkovsky to study conception, data analysis, manuscript writing and critical revision for important intellectual content. All authors read and approved the final version of the manuscript.

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The evaluation of meticulous and humanized nursing management mode on patient's physiology, psychology and comfort level as well as the incidence of adverse events in operating room

With the development and improvement of medical industry, patients as well as their families have put forward a series of new requirements regarding to the comfort of surgical treatment and the quality of nursing services. In order to further improve the