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ORIGINAL RESEARCH ARTICLE

Trends in the treatment and survival of heart failure patients: a nationwide population-based study in the Czech Republic

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Abstract

Aims A retrospective nationwide observational analysis of diagnoses, procedures, and treatment reported to the Czech National Registry of Reimbursed Health Services between 2012 and 2018.

Methods and results Prevalence of heart failure (HF) patients increased from 176 496 (1679.4 per 100 000 population) in 2012 to 285 745 (2689.0 per 100 000 population) patients in 2018 (mean age 74.4 ± 12.8 years). In the last years, a stable incidence of HF patients was observed (544 per 100 000 population in 2016 vs. 551 per 100 000 population in 2018; $P = 0.310$). Mortality rate decreased from 20.55% in 2012 to 15.89% in 2018. The number of hospitalized patients remained similar (318.2 per 100 000 population in 2012 vs. 311.8 per 100 000 population in 2018; $P = 0.479$). The most used drugs were diuretics (173 295; 60.6%) and beta-blockers (178 823; 62.6%), followed by angiotensin-converting enzyme inhibitors/angiotensin II receptor blockers (angiotensin-converting enzyme inhibitors 120.581; 42.2%; angiotensin II receptor blockers 47 216; 16.5%). Even though the whole number of implanted devices in HF patients increased steadily (from 25 205 in 2012 to 45 363 in 2018), the prevalence of all devices (pacemakers and defibrillators) in the HF patients remained about the same (14.3% in 2012; 15.9% in 2018).

Conclusions The study included all patients with HF in the Czech Republic. These are the first nationwide data of HF epidemiology in the Eastern bloc. The incidence of HF remains stable in the last years. Due to aging of the population, the prevalence of HF significantly increased in the last 6 years. Despite a continuous increase in the prevalence of HF and a suboptimal utilization of its pharmacological therapy, mortality decreased, and the number of hospitalized patients remained the same.

Keywords Heart failure; Incidence; Prevalence; Treatment; European Union; Czech Republic

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Introduction

Heart failure (HF) still poses a major global public health challenge. Despite advantages in treatment in the last decades, a slight decline in incidence of HF[1,2] and a decline in hospitalization rate in several countries,[3] a steadily rising overall prevalence was documented[2] and the mortality is still reported to be about 25% at 3 years and 50% at 5 years after the HF is diagnosed.[4] Considering HF patients in the Czech Republic, we have data from several HF registries,[5,6] but no registry evaluated all HF patients in the whole country. It is unknown if observations from within-registry analyses can be extrapolated to non-enrolled patients. We can anticipate more frequent utilization of novel up-to-date evidence base diagnostic and

treatment strategies in hospitals involved in HF registries.[7] This can be potentially associated with a better outcome of the enrolled patients. Differences in the case mix of the registries, age and gender distributions, and co-morbidities of the participants can influence the interpretation of the results. To obtain nationwide data on HF, we accessed and analysed data from the Czech National Registry of Reimbursed Health Services (NRRHS), which contains a complete dataset of medical claims to all health insurance companies operating within the country. Of note, only few countries have reported nationwide trends in the incidence and mortality of HF. Almost no data are available considering the HF epidemiology from the former Eastern bloc countries. Therefore, results of this study might be important for the planning of health expenditures, clinical research, and selection of countries for clinical trials.

Study aim

The aim of this study is to analyse prevalence, incidence, hospitalizations, and mortality of all HF patients in the whole country in recent years.

Methods

Study design

This study is a retrospective observational analysis of diagnoses, procedures, and treatment reported to the Czech National Registry of Reimbursed Health Services (NRRHS) between 2010 and 2018. The main time period used in the study was 2012–18; time period 2010–11 was included as a medical history of patients only. The only exception was different types of cancer. These were evaluated based on the data from the Czech National Cancer Registry (CNCR).

Patients' selection definition, data extraction, and study timeline

The patients' cohort was selected based on the International Classification of Diseases (ICD-10) data. All patients with I50.x diagnosis code were selected and considered as patients with HF. All HF-connected records in every single patient were analysed. The data obtained from NRRHS include both inpatient and outpatient departments. All data were obtained in accordance with the national law and policy as anonymized results of pre-specified analyses. Data were anonymized before the linked database was released to the research group. Because this was a retrospective, anonymized study and the data are collected according to law no. 372/2011 about health care services, no informed consent was required.

Co-morbidities

The medical history of all HF patients was assessed, and all co-morbidities recorded during 2010–18 period. In addition, different types of cancer were evaluated based on the data from CNCR.

Treatment

The *pharmacotherapy* was evaluated separately for individual drug classes = diuretics, angiotensin-converting enzyme inhibitor (ACEi), angiotensin II receptor blockers (ARB), angiotensin receptor–neprilysin inhibitor (ARNI), beta-blockers, mineralocorticoid receptor antagonists (MRA), *If* channel inhibitors (ivabradin), digoxin, warfarin, direct anticoagulants (DOAC), and hypolipidaemics.

Pacemaker (PM) and cardioverter–defibrillator (ICD) implantation: Implantations and device interrogations were evaluated to assess the number of HF patients with devices. Because NRRHS data on ICDs are available from 2010 thereafter, and device interrogations are reported non-specifically as PM/ICD interrogations, it is difficult to precisely evaluate the exact proportion of patients implanted with ICD before 2010. Therefore, we are reporting a combined category PM/ICD that includes all patients with these devices.

Statistical methodology

Standard descriptive statistics were used to summarize the data: categorical variables were described by absolute and relative frequencies, whereas continuous variables were described by means and standard deviations. The significance of trend between years 2012 and 2018 was tested by linear regression analysis. For comparison with European data, a part of results is standardized using the 2013 European Standard Population (ESP). The analysis was computed using the Vertica database for data pre-processing and SPSS 25.0.0.1 and R-3.6.1 for the statistical analysis of data. The level of statistical significance was set at $\alpha = 0.05$ for all analyses.

Results

Incidence, prevalence, mortality, and hospitalizations

Age structure and gender of patients with history of HF in 2018 are depicted in *Table 1* in absolute numbers and numbers per 100 000 (Czech population, 2018). In 2018, there were 285 745 patients with HF (mean age 74.4 ± 12.8), slightly more men (145 297; mean age 71.5 ± 12.5) than women (140 432; mean age 77.4 ± 12.3). The majority of

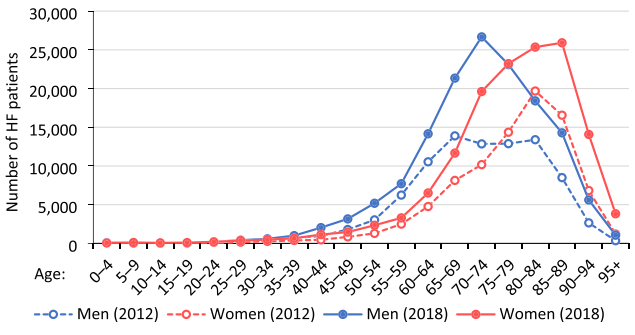
Table 1 Age structure of patients with history of heart failure in 2018—absolute numbers and numbers per 100 000 (Czech population, 2018)

Age category	Total		Men		Women	
	Absolute number	Per 100 000	Absolute number	Per 100 000 men	Absolute number	Per 100 000 women
0–4	145	26	89	31	56	20
5–9	224	39	114	38	110	39
10–14	141	26	71	26	70	27
15–19	197	42	96	40	101	45
20–24	406	79	206	79	200	80
25–29	775	115	412	119	363	111
30–34	1075	148	590	158	485	138
35–39	1662	207	1000	242	662	171
40–44	3172	339	2037	424	1135	249
45–49	4624	606	3163	807	1461	393
50–54	7519	1081	5182	1464	2337	684
55–59	11 005	1767	7711	2476	3294	1058
60–64	20 664	3001	14 155	4258	6509	1828
65–69	33 011	4840	21 344	6749	11 667	3189
70–74	46 282	7984	26 672	10 506	19 610	6019
75–79	46 308	12 477	23 095	15 257	23 213	10 562
80–84	43 761	19 203	18 410	22 119	25 351	17 525
85–89	40 187	28 295	14 278	31 368	25 909	26 846
90–94	19 677	38 920	5606	42 396	14 071	37 688
95+	4894	50 506	1066	52 076	3828	50 085
Total	285 745	2689	145 297	2778	140 432	2602
<50	12 421	189	7778	231	4643	146
50–74	118 481	3625	75 064	4788	43 417	2552
75+	154 827	19 322	62 455	21 143	92 372	18 258

HF patients were older than 70 years (70.4%). The trend of change in age structure is shown in *Figure 1*.

Basic epidemiologic characteristics of HF patients (per 100 000 population) are mentioned in *Table 2*. From all citizens of the Czech Republic (10.51 million in 2012; 10.65 million in 2018), there were 176 496 patients with HF in 2012 (1679.4 per 100 000 population). The number of these patients grew constantly towards 285 745 patients (2689.0 per 100 000 population) with HF in 2018. In the last 3 years, the incidence was around 58 000 HF patients per year (around 550 per 100 000 population); there were 58 577 newly diagnosed HF patients in 2018. Data were not sufficient to precisely assess an incidence of new HF patients before 2015. The number of HF patients that died each year increased from 36 262 (345.0 per 100 000 population) in 2012 to 45 395 (427.2 per 100 000 population) in 2018, but because the prevalence of HF patients grew significantly, the annual mortality rate actually decreased (from 20.55% in 2012 to 15.89% in 2018). Despite the increase in the prevalence of HF patients, the absolute number of hospitalized patients slightly decreased from 33 441 (318.2 per 100 000 population) in 2012 to 33 136 (311.8 per 100 000 population) in 2018. The significance of trend of all these changes from 2012 to 2018 in individual subgroups according to age and gender is mentioned in *Table 2*.

Figure 1 Age structure of patients with heart failure (HF) in 2012 and 2018.



From all prevalent patients in 2018, 101 870 (35.7%) with an average age of 76.1 ± 11.4 were hospitalized at least once for HF during the 2010–18 time period and the rest of the patients (n = 183 875; 64.3%) with an average age of 73.5 ± 13.4 were treated in an outpatient setting only. The interquartile range (IQR) of the hospitalized patients was 77 (69–85) and of the non-hospitalized 75 (67–83). Thus, there was a shift of 2 years in the age structure.

The demographic characteristics of HF patients *recalculated on 100 000 citizens and age standardized* according to 2013 European standard population are mentioned in *Table 3* so our data can be more easily compared with other international data.

Co-morbidities

Cardiovascular and oncological diseases were common in HF patients. In 2018, the most prevalent were arterial

Table 2 Basic epidemiologic characteristics of heart failure patients (per 100 000 population)

	2012	2013	2014	2015	2016	2017	2018	Significance of trend
Incidence								
All	—	—	—	—	544.4	544.6	551.2	0.310
<65 years	—	—	—	—	124.6	123.4	128.0	0.495
≥65 years	—	—	—	—	2386.9	2338.2	2307.1	0.080
Men	—	—	—	—	554.7	557.1	568.5	0.229
Women	—	—	—	—	534.3	532.4	534.2	0.983
<65 years, men	—	—	—	—	166.2	165.3	170.8	0.438
<65 years, women	—	—	—	—	81.5	79.9	83.6	0.612
≥65 years, men	—	—	—	—	2637.5	2589.6	2574.3	0.184
≥65 years, women	—	—	—	—	2208.0	2157.7	2114.0	**0.026**
Prevalence								
All	1679.4	1923.1	2126.5	2311.3	2431.8	2567.7	2689.0	<**0.001**
<65 years	399.5	451.2	493.8	528.0	553.0	576.3	602.7	<**0.001**
≥65 years	8155.2	9064.0	9768.0	10 393.4	10 678.3	11 046.8	11 348.2	<**0.001**
Men	1716.6	1967.9	2173.1	2366.0	2500.8	2643.1	2777.9	<**0.001**
Women	1643.6	1879.9	2081.5	2258.5	2365.1	2494.7	2602.5	<**0.001**
<65 years, men	540.8	606.7	664.2	708.3	738.7	766.7	797.9	<**0.001**
<65 years, women	253.8	290.9	317.9	341.7	360.9	378.8	399.7	<**0.001**
≥65 years, men	9117.1	10 131.7	10 861.2	11 572.9	11 946.8	12 374.4	12 764.0	<**0.001**
≥65 years, women	7492.5	8320.0	8999.5	9557.6	9773.1	10 093.4	10 325.1	<**0.001**
Mortality								
All	345.0	368.8	375.4	410.3	395.9	414.2	427.2	**0.001**
<65 years	49.7	49.8	47.4	48.5	45.9	47.1	45.9	**0.012**
≥65 years	1839.5	1916.4	1910.6	2049.7	1932.3	1977.4	2009.8	0.067
Men	344.5	371.2	375.1	405.7	399.6	414.6	427.2	<**0.001**
Women	345.6	366.6	375.8	414.6	392.4	413.9	427.2	**0.003**
<65 years, men	69.8	69.5	66.8	68.3	63.9	66.4	64.5	**0.020**
<65 years, women	28.9	29.5	27.5	28.0	27.3	27.2	26.6	**0.008**
≥65 years, men	2073.3	2180.2	2150.3	2279.4	2199.1	2220.4	2256.4	**0.048**
≥65 years, women	1678.3	1732.6	1742.1	1886.8	1741.8	1802.9	1831.6	0.109
Hospitalizations								
All	318.2	314.3	335.4	320.3	319.1	315.9	311.8	0.479
<65 years	58.8	56.0	56.9	54.2	54.4	51.2	50.3	<**0.001**
≥65 years	1630.8	1567.3	1638.8	1526.3	1480.9	1443.0	1397.2	**0.003**
Men	327.7	326.8	346.6	333.0	334.3	333.6	332.9	0.665
Women	309.0	302.2	324.6	308.0	304.4	298.7	291.3	0.157
<65 years, men	84.8	80.9	82.2	78.8	79.0	75.1	73.9	<**0.001**
<65 years, women	32.0	30.2	30.8	28.8	29.0	26.4	25.8	<**0.001**
≥65 years, men	1856.9	1801.3	1869.0	1745.0	1702.7	1674.3	1639.2	**0.003**
≥65 years, women	1475.0	1404.3	1477.0	1371.3	1322.6	1276.8	1222.3	**0.002**

Hospitalizations, number of hospitalized patients in the given year; Incidence, number of new heart failure patients in the given year; Mortality, number of patients deceased in the given year; Prevalence, number of patients with a history of heart failure. Bold indicates significant *P* values < 0.05.

Table 3 Basic epidemiologic characteristics of heart failure per 100 000 population, age standardized according to 2013 European standard population

	2012	2013	2014	2015	2016	2017	2018	Significance of trend
Incidence	—	—	—	—	626.1	612.9	608.4	0.176
Prevalence	2072.0	2322.8	2523.9	2697.9	2777.7	2876.3	2961.1	<**0.001**
Mortality	471.6	492.5	493.7	531.9	495.2	508.0	514.0	0.119
Hospitalizations	402.4	387.8	407.2	380.0	372.4	360.4	350.0	**0.005**

Hospitalizations, number of hospitalized patients in the given year; Incidence, number of new heart failure patients in the given year; Mortality, number of patients deceased in the given year; Prevalence, number of patients with a history of heart failure. Bold indicates significant *P* values < 0.05.

hypertension (92.6% of all HF patients) and coronary artery disease (77.9% of all HF patients). Moreover, 62.8% of HF patients in 2018 had a history of arrhythmias, 49.7% of them had a history of atrial fibrillation. Diabetes mellitus (41%) and hyperlipoproteinaemia (49.6%) were also highly prevalent. Oncological disease was present in 23.6% of patients. All other diseases are reported in *Table 4*.

Pharmacological treatment

The most important drugs used in HF patients from 2012 to 2018 are listed in *Table 5*. The most frequently used drugs in 2018 in HF patients were diuretics (173 295; 60.6%) and beta-blockers (178 823; 62.6%), followed by ACEi/ARBs (ACEi 120.581; 42.2%; ARBs 47 216; 16.5%) and MRA (96 214;

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Table 4 Co-morbidities in heart failure patients in 2018

	N	% of all HF patients
(1) Cardiovascular diseases		
Arterial hypertension	264 499	92.6
Coronary artery disease	222 585	77.9
Acute myocardial infarction	44 100	15.4
Valve disease	85 611	30.0
Cardiomyopathy	28 487	10.0
Arrhythmias	179 576	62.8
Atrial fibrillation	141 988	49.7
Stroke	50 266	17.6
(2) Neoplasms (C00–D48)	67 393	23.6
Malignant neoplasm of		
lip, oral cavity, and pharynx (C00–C14)	949	0.3
oesophagus (C15)	191	0.1
stomach (C16)	830	0.3
colon, rectosigmoid junction, and rectum (C18–C20)	8076	2.8
liver and intrahepatic bile ducts (C22)	296	0.1
gallbladder and other and unspecified parts of biliary tract (C23, C24)	302	0.1
pancreas (C25)	480	0.2
larynx (C32)	494	0.2
trachea, bronchus, and lung (C33, C34)	2754	1.0
malignant melanoma of skin (C43)	2232	0.8
other and unspecified malignant neoplasm of skin (C44)	23 065	8.1
peripheral nerves and autonomic nervous system (C47, C49)	259	0.1
breast (C50)	7638	2.7
cervix uteri (C53)	979	0.3
corpus uteri, uterus—part unspecified (C54, C55)	3109	1.1
ovary (C56)	700	0.2
prostate (C61)	7314	2.6
testis (C62)	288	0.1
kidney, except renal pelvis (C64)	3532	1.2
bladder (C67)	2945	1.0
meninges, brain, spinal cord, and cranial nerves (C70–C72)	191	0.1
thyroid gland (C73)	824	0.3
Hodgkin lymphoma (C81)	407	0.1
non-Hodgkin lymphoma (C82–C86)	1474	0.5
multiple myeloma and malignant plasma cell neoplasms (C90)	534	0.2
leukaemia (C91–C95)	1038	0.4
other malignant neoplasms	1962	0.7
In situ neoplasms (D00–D09)	5901	2.1
Benign and uncertain behaviour neoplasms (D10–D36, D37–D48)	2283	0.8
(3) Other diseases		
Diabetes mellitus	117 265	41.0
Dyslipoproteinaemias	141 764	49.6
Chronic obstructive pulmonary disease	91 052	31.9
Sleep apnoea	7664	2.7
Renal failure	73 998	25.9
Dementia	34 534	12.1
Alzheimer's disease	17 010	6.0

33.7%). Recently, the modern treatment using ARNI emerged. In 2018, this drug was prescribed only in 2862 (1%) patients.

Non-pharmacological treatment

The numbers and types of implanted devices in all HF patients are reported in *Table 5*. The numbers presented in the table are a sum of implanted devices. Because there were no data about the type of the implanted device before 2010 and the code for device interrogation is the same for PM and ICD, we cannot be sure about the type of the device if it was implanted before 2010. Thus, the majority of patients with a device implanted before 2010 are assessed as 'undetermined device (PM or ICD)'. With more patients implanted and re-implanted in the following years, the precise type of the device could have been specified. In 2018, even considering the subgroup of HF patients with undetermined pacing device type (3257; 1.1%), there were more patients with a PM (23 759; 8.3%) than with an ICD (18 347; 6.4%). Even though the whole number of implanted devices in HF patients rose steadily (from 25 205 in 2012 to 45 363 in 2018), the

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Table 5 Pharmacotherapy and pacemaker or implantable cardioverter–defibrillator treatment in heart failure patients—proportion of treated patients from all heart failure patients

	2012	2013	2014	2015	2016	2017	2018	Significance of trend
Diuretics	66.7%	65.1%	65.0%	63.8%	63.0%	61.7%	60.6%	**<0.001**
ACEi	52.3%	50.1%	48.8%	46.9%	45.4%	43.7%	42.2%	**<0.001**
ARB	18.6%	18.1%	18.2%	17.6%	17.3%	16.8%	16.5%	**<0.001**
ARNI	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	1.0%	0.076
Beta-blockers	61.8%	62.0%	62.9%	62.7%	63.3%	62.9%	62.6%	0.099
MRA	37.9%	36.8%	36.7%	35.9%	35.2%	34.4%	33.7%	**<0.001**
If channel inhibitor	0.8%	0.9%	1.0%	1.0%	1.2%	1.3%	1.3%	**<0.001**
Digoxin	15.8%	14.6%	13.4%	12.4%	11.7%	11.0%	10.2%	**<0.001**
Warfarin	28.3%	27.8%	27.5%	26.8%	26.6%	25.9%	25.1%	**<0.001**
Direct anticoagulants	1.6%	3.7%	5.8%	7.2%	8.4%	9.8%	11.5%	**<0.001**
Statins	39.4%	38.5%	38.1%	37.4%	37.4%	36.8%	36.5%	**<0.001**
PM + ICD (total)	14.3%	14.6%	14.9%	15.1%	15.4%	15.7%	15.9%	**<0.001**

ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blockers; ARNI, angiotensin receptor–neprilysin inhibitor; ICD, implantable cardioverter–defibrillator; MRA, mineralocorticoid receptor antagonists; PM, pacemaker. Bold indicates significant *P* values < 0.05.

prevalence of all devices (PMs and ICDs) in the HF patients remained about the same (14.3% in 2012; 15.9% in 2018).

Discussion

So far there are very limited data reporting nationwide trends in the incidence and mortality of HF in Eastern European countries. We have retrospectively evaluated data from all citizens of the Czech Republic (*N* = 10.6 million in 2018) that were examined in either inpatient or outpatient department and had an established diagnosis of HF regardless of its type, severity, treatment, or date of onset (*N* = 285 745 in 2018). Because we were analysing data from all patients of the entire country, the case mix is different than in the HF registries usually performed in specialized centres. In a country from the former Eastern bloc, an analysis of this extent has not yet been performed. Several clinical trials in HF patients have demonstrated changes in morbidity and mortality from various medical and device therapies. However, the external validity of outcome of patients in specific HF registries is limited because of selectivity of individual hospitals and/or patients' participation. Moreover, mortality rates calculated among inpatients may not apply to patients diagnosed only in the outpatient setting.[3] Data on temporal trends based on hospitalized patients suggest that the incidence of HF may be decreasing, at least in patients diagnosed with HF in the hospital and especially more in HF with reduced ejection fraction (HFrEF) patients.[1,8]

Incidence and prevalence

Our data show a stable incidence of 544 to 551 HF patients per 100 000 population per year. The incidence of HF remains similar in patients <65 years (124.6 per 100 000 population in 2016; 128.0 per 100 000 population in 2018; *P* = 0.495) as well as in patients >65 years (2386.9 in 2016; 2307.1 per 100 000 population in 2018; *P* = 0.080).

Although the prevalence of HF depends on the definition applied, it is reported to be 1–2% in the adult population in developed countries.[9] Although the estimates vary widely in different reports, the trend of an increasing prevalence of HF is clear. We have also observed a dramatic increase in the prevalence of HF in citizens of the Czech Republic. Despite a relatively stable number of citizens (10 509 in 2012; 10 650 in 2018), the number of HF patients rose from 176 000 in 2012 (1679.4 per 100 000 population) to 285 000 in 2018 (2689.0 per 100 000 population). The increasing prevalence (interannual increase of 5–6%) could be attributable to a better recognition and treatment of the HF and also to a better treatment of coronary artery disease, especially better recovery from acute myocardial infarction (AMI) and cardiac arrests survival.[10] Also, more sensitive diagnostic measures help us to diagnose HF patients earlier leading to a longer life post diagnosis (the so-called 'lead time bias').

Age and gender

The majority of HF patients in our study were older than 75 years (19 322 per 100 000 population in 2018). A total of 3625 HF patients per 100 000 population in 2018 were 50–74 years old, and only 189 HF patients per 100 000 population in 2018 were younger than 50 years. These observations are in agreement with the known fact that HF is less common under the age of 60 years.[11]

Men were significantly more prevalent in HF patients <65 years (797.9 per 100 000 population in 2018) than women (399.7 per 100 000 population in 2018) and slightly in patients >65 years (12 764.0 vs. 10 325.1 per 100 000 population in 2018). In general, women with HF were older than men (6 years older in average). The gender distribution in different age subgroups is evident from *Table 1*. HF is more

common in men of any age, but because women live longer, in the oldest subgroups of HF patients, women are more often present.

Hospitalizations

Despite aging of the population and a significant increase in the prevalence of HF patients, the absolute number of hospitalized patients in our country stayed roughly the same (33 441 in 2012 = 18.95% of all HF patients; 33 136 in 2018 = 11.6% of all HF patients; interannual change of hospitalizations incidence −0.9%). We have observed a shift of 2 years in the age structure. The IQR of the hospitalized patients was 77 (69–85) and of the non-hospitalized 75 (67–83).

The ESC-HF Long-Term Registry reported a significantly higher number of hospitalized patients (28.1% of all-cause hospitalizations in HF patients in 1 year).[12] Despite a lower number of hospitalized patients, the similar absolute number in different years of follow-up is in agreement with the global trend. A comparable absolute number of discharges for HF in a 10 year period were reported elsewhere.[10] Of European countries, we have data from national HF registries; the most comparable is Slovenia.[13] The patient group is a little bit different due to different MKN codes used to define HF and the focus of the registry on HF hospitalizations. Nevertheless, when comparing an age-standardized HF patients' population according to 2013 European standard population, our HF patients were younger (mean age 74.4 ± 12.8 years) in comparison with the Slovenian registry (median age 78 years). In the German national registry, from 2000 to 2013, the absolute number of HF-related hospitalizations increased by 28.4% (261–335 per 100 000 population after age standardization).[14] We have observed an opposite trend; the number of hospitalizations for HF per 100 000 population, age standardized according to 2013 European standard population, decreased from 402.4 in 2012 to 350.0 in 2018 (P = 0.005). Despite an increasing prevalence, in some countries, a decrease in hospitalizations rate was also reported.[3]

Mortality

The number of HF patients that died each year has increased (from 36 262 in 2012 to 45 395 in 2018), but because the prevalence of HF patients grew significantly, the mortality rate actually decreased (from 20.55% in 2012 to 15.89% in 2018). Comparable mortality rates were observed in other countries.[15,16] On the other hand, others have reported no apparent change in mortality in the last decade in HF patients.[8] Despite a decreasing trend, all-cause mortality of HF patients was significantly higher in comparison with the ESC-HF Long-Term Registry (8.1% all-cause deaths in 1 year).[12] The possible explanation could be the fact that only patients seen at cardiology outpatient clinics and not patients with chronic HF seen in other ambulatory facilities or those seen by other professionals such as internists were included in the ESC-HF Long-Term Registry. There were no differences in mortality between men and women (22 345 vs. 23 050 in 2018). There was an anticipated difference in mortality in younger and older HF patients (3 931 = 7.6% mortality in patients <65 years vs. 41 464 = 17.7% mortality in patients >65 years).

Co-morbidities

Due to the registry data, we are unable to specify the aetiology of HF in our patients. The data from echocardiography and/or coronary angiography are not available within the patient database. However, the majority of patients (77.9% of HF patients in 2018) had coronary artery disease, but this does not mean that they had a disease significant enough to explain the development of HF. Cardiovascular and oncological diseases were fairly common in HF patients. In 2018, the most prevalent co-morbidities were arterial hypertension and coronary artery disease. Arterial hypertension was present in the vast majority of our patients (92.6% of HF patients in 2018). Diabetes mellitus was documented in 41.0% of our patients. Only 58.5% had a treated arterial hypertension and 31.4% had diabetes mellitus in the ESC-HF Long-Term Registry. These co-morbidities are likely to be under-reported in the hospitalization registries, because some co-morbidities may be treated only in primary care. Our data show that more than 60% of HF patients had a history of arrhythmias, mostly atrial fibrillation (49.7% of HF patients in 2018). Atrial fibrillation was thus also far more prevalent when compared with the ESC-HF Long-Term Registry (21.5% of HF patients) and FAR-NHL registry (34.8% of HF patients).[5,12] A striking finding was that oncological diseases were present in one-fourth of patients; the majority of those were classified as malignant (22% of all HF patients had a diagnosis of malignancy). These diagnoses were far more prevalent when compared with similar patient groups. Only 13% of HF patients enrolled in the *SwedeHF* registry had a malignancy within 3 years from enrolment.[7] The most possible explanation of this difference could be that all diagnoses from the whole life of all HF patients were assessed in our database. Data were evaluated since 1979, meaning we are reporting 40 years of history of malignancies in our HF population. In the *SwedeHF* registry for comparison, only 3 years of patients' history were taken into account. However, only 8.3% of cancer diagnoses (non-metastatic solid tumour, leukaemia, lymphoma, and metastatic cancer) were documented in a long-term Danish nationwide cohort study.[3] Explanation could also be in meticulous central reporting of cancers (including early stages) in the Czech Republic into the national register. Another reason could be an often-present exclusion of C44 diagnosis code

(melanoma and other malignant neoplasms of skin) in HF registries.

Pharmacotherapy

The most used drugs for the treatment of HF in our patients were diuretics, even though their impact on mortality has not been studied in randomized controlled trials (RCTs), and beta-blockers, followed by ACEi/ARBs. The beta-blockers were used in less than 70% of patients. When compared with the FAR-NHL registry of Czech chronic HF patients with 93.8% of chronic HF patients on beta-blocker, there is still an evident under-treatment when compared with a sought-after standard of care.[5] However, the prescription rate is similar to other similar reports. In UK HF patients, 72% of them were treated with beta-blocker.[17] This under-treatment is even more evident in ACEi/ARBs and MRAs. In our patient group, 58.7% of patients were on ACEi or ARB. In the FAR-NHL registry, 88.3% of patients were on ACEi or ARB. A total of 33.7% of our HF patients had MRA. This is a strikingly lower number when compared with Czech chronic HF patients in the FAR-NHL registry (65.7% were on MRA).[5] The room for improvement to achieve a guideline-recommended process of care is evident. However, the number of patients treated with MRA is similar to the UK HF patients (28% on MRA).[17] The explanation of this under-treatment compared with the registries could be the fact that patients in the analysed population are added successively. This means that patients treated for HF in 2012 are still included in the analysed population of HF patients in 2018 if they are still alive even if they are not treated for HF anymore. In 2018, even considering a subgroup of HF patients with undetermined device type, there were more patients with a PM than with an ICD. The whole number of implanted devices in HF patients rose steadily.

Study limitations

The prevalence of HF is a combination of patients that were hospitalized for HF and those that had an HF diagnosis recorded in an outpatient setting in GP (primary care) or an ambulatory specialist office. The true prevalence is unknown and could be lower or higher: lower in case that some patients have the HF diagnosis assigned incorrectly, especially in outpatient setting outside of specialized cardiology care, and higher if there are untreated HF patients unrecognized by the health care system. Thus, the prevalence is not the true prevalence but only our estimate based on available data. We were not able to distinguish HF with preserved ejection fraction and HFrEF patients in our analysis. The data from echocardiography examinations and levels of brain natriuretic peptide are not reported to the insurance companies and cannot thus be obtained from the analysed database. We could extrapolate data from other databases (e.g. the Czech FAR-NHL registry), but they do not contain all HF patients in the whole country and thus could be linked with a serious bias. A large number of patients in our database diminish the chance of selection bias. On the other hand, it inevitably leads to a low detail of individual patients' data. Data from echocardiography, electrocardiogram, and laboratory samples are missing entirely. We cannot rule out a population bias because all patients were diagnosed and treated in one developed country with highly advanced health care. Individual patient records might be filled out imperfectly. These potential imperfections should not have an impact on the trends of the individual variables. There is no single classification system for the causes of HF, with much overlap between potential categories. This makes a precise assessment of a single diagnosis of HF in such a database challenging. We do not provide data about HF incidence before 2016 since in the period 2010–15, the measured incidence is influenced by patients with incidence prior to 2010 who are indistinguishable from the patents with incidence from 2010 onwards (incidence in these years is a mixture of prevalence and incidence); since 2016, this bias is negligible. In the early years of follow-up, we are not sure about the precise type of implantable device type. This relates to patients implanted before 2010 who are identified only by procedures related to care provided to patients with implantable device recorded in database since 2010. The number of these patients decreases in time due to mortality and implantation of new devices (either re-implantation or upgrade) since after 2010, we can differentiate PM vs. ICD according to recorded type of implanted device.

Conclusions

The study included all patients with HF in the Czech Republic. These are the first nationwide data of HF epidemiology in Eastern European countries. The incidence of HF remains stable in the last years. Due to aging of the population, the prevalence of HF significantly increased in the last 6 years. Despite a continuous increase in the prevalence of HF and a suboptimal utilization of its pharmacological therapy, mortality decreased, and the number of hospitalized patients remained the same.

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This study has been implemented to the Czech Republic national action plan of cardiovascular prevention. The project aims for the early and systematic detection of patients with cardiovascular risks connected with the effective treatment

intervention. The long-term goal of the project is the 5% reduction of cardiovascular mortality during the next 10 years.

Conflict of interest

None declared.

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