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RESEARCH AND
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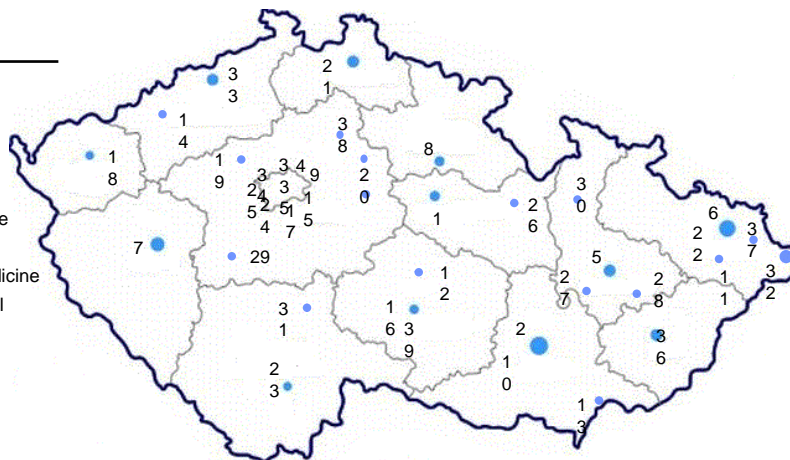
CLINICAL CHARACTERISTICS AND MORTALITY IN ALL CZECH PATIENTS AFTER PACEMAKER IMPLANTATION IN THE LAST DECADE

Miloš Táborský

21.10.2022

39 cardiac pacing centers in Czech Republic (2023)

- 1 Kardiologické centrum AGEL a.s.
- 2 The University Hospital Brno – Dep. of Cardiology
- 3 The University Hospital Motol – Children' Cardiocentre
- 4 The University Hospital Motol – Dep. of Cardiology
- 5 The University Hospital Olomouc – 1st Dep. of Medicine
- 6 The University Hospital Ostrava – Dep. of Cardiovascular Medicine
- 7 The University Hospital Plzeň – Dep. of Cardiology, arytmology
- 8 The University Hospital Hradec Králové – 1st Dep. of Internal Medicine
- 9 The University Hospital Královské Vinohrady – 3rd Dep. of Internal Medicine – Cardiology
- 10 The St. Anne's University Hospital Brno – Dep. of Cardiology
- 11 Hospital in Frýdek-Místek – Dep. of Internal Medicine
- 12 Hospital in Havlíčkův Brod – Dep. of Internal Medicine
- 13 TGM Hospital Hodonín – Centre of Cardiosimulation
- 14 Chomutov – Dep. of Internal Medicine
- 15 The Institute of Clinical and Experimental Medicine – Department of Cardiology
- 16 Jihlava – Dep. of Cardiology
- 17 The University Hospital Bulovka – Cardiology
- 18 Karlovy Vary – Kardiocentrum
- 19 Kladno – Dep. of Internal Medicine
- 20 Kolín – Dep. of Internal Medicine
- 21 Liberec – Cardio Centre
- 22 Ostrava City Hospital – Cardiology
- 23 Hospital in České Budějovice – Cardio Centre
- 24 Hospital of Merciful Sisters – Dep. of Internal Medicine
- 25 Hospital „Na Homolce“ – Dep. of Cardiology
- 26 Hospital in Ústí nad Orlicí – Dep. of Internal Medicine



- 27 Prostějov – Dep. of Internal Medicine
- 28 Přerov – Dep. of Internal Medicine
- 29 Příbram – Dep. of Internal Medicine
- 30 Šumperk – Dep. of Internal Medicine
- 31 Tábor – Dep. of Internal Medicine
- 32 Třinec – Cardio Centre
- 33 Ústí nad Labem – Dep. of Cardiology
- 34 ÚVN – Dep. of Cardiology
- 35 The General University Hospital in Prague – 2nd Dep. of Internal Cardiovascular Medicine
- 36 Zlín – Dep. of Internal Medicine
- 37 Havířov Hospital with Polyclinic – Dep. of Internal Medicine
- 38 Mladá Boleslav – Dep. of Internal Medicine
- 39 Kardiocentrum Vysocina CZ, a.s.

Introduction

- Effective monitoring of healthcare interventions and efficient allocation of resources can be achieved through the implementation of national registries
- However, managing and establishing these registries can be challenging as data inadequacies and insufficiencies may arise, which require significant investments in terms of finances and human resources to ensure data accuracy and high-quality collection .
- Despite the need for mandatory participation in National Registries to obtain comprehensive data, many countries still rely on voluntary participation, which results in incomplete databases .
- The Pacemaker (PM) Registry of the Czech Society of Cardiology (REPACE) collects information about demographics, clinical characteristics, main indications for PM therapy, device types, implantation details and complications from all centers in the Czech Republic. It was established in 1990 by prof. J. Lukl in Olomouc

Methodology and Data Sources

- Analysis is based on data managed by the *Institute of Health Information and Statistics of the Czech Republic (IHIS CR)*, which are collected within the *National Health Information System (NHIS)* and *national health registries* combined with the data of registry of the Czech Society of Cardiology REPACE.
- 1. *National Register of Reimbursed Health Services (NRRHS)* contains data from health insurance companies in both inpatient and outpatient areas, including complete data on reported diagnoses, procedures and treatments. At the time of analysis, data were available for the period 01/2010-12/2021.
- 2. *Information System Deaths* is the primary source of information on each death. It is completed immediately after the examination of the deceased by the examining physician, who, in addition to basic socio-demographic characteristics, also records the sequence of causes leading to death (coded using ICD-10). At the time of analysis, data were available until the end of 2021.
- 3. REPACE registry aims to create a central registry for detailed clinical data of pacemaker implantation in indicated patients. At the time of analysis, data were available until the end of 2021.

Event definition

- **Identification of patients with implanted devices:** In the NRRHS data, the implanted device is identified by the reported medical devices. The patient should also have a reported procedure code for the implantation performed; based on the procedure code and also on the available patient history going back to 2010, it is possible to distinguish with sufficient accuracy between 1st PM implantations and PM replacements performed.
- *1st PM implantation is defined by the procedure code:* 07234 (*) - Surgical implantation or replacement of permanent pacing system without epicardial leads; 17249 - 1st implantation of leadless pacemaker for single-chamber right ventricular pacing; 17625 - 1st implantation of biventricular pacing system; 17630 - 1st PM implantation for cardiac contractility modulation; 55211 (*) - Pacemaker implantation for single-chamber pacing; 55213 - 1st PM implantation for biventricular pacing. *PM replacement is defined by the procedure code:* 55219 - Cardiac PM replacement without vein intervention. Some procedures (*) are non-specific and do not allow direct differentiation between 1st PM implantation and PM replacement.

Statistical analysis

- Standard descriptive statistics were used for analysis.
- Continuous parameters were described using the mean and standard deviation, while binary or categorical parameters were described using absolute and relative numbers.
- Overall survival was calculated using the Kaplan-Meier method, and relative survival was calculated using the Pohar-Perme method.
- The probability of hospitalization for heart failure was calculated using the cumulative incidence method, with death considered as a competing event.
- The level of statistical significance used in all analyses was $p = 0.05$.
- Analyses were performed with SPSS 28.0.1.1 (IBM Corp., Armonk, NY, USA) and the R-package relsurv

CLINICAL CHARACTERISTICS AND MORTALITY IN IN ALL CZECH PATIENTS AFTER PACEMAKER IMPLANTATION IN THE LAST DECADE

- Retrospective observational analysis of pacemakers' implantation **in all Czech patients (n=82,791; 47,070 (56.9%) men**, 75.9 ± 10.4 years old) between 2010 and 2021. Almost 114,000 pacemakers were implanted between 2010 and 2021, of which 27.9% were single-chamber, 67.4% were dual-chamber and 4.6% were biventricular.
- The annual number of implantations has been steadily increasing with a 6% annual decline in 2020 with increased mortality and reductions in care provided, likely related to COVID-19.
- The observed 5-year relative survival was 88.6% (overall survival 60.6%) and the 10-year relative survival was 75.9% (overall survival 32.7%).
- Causes of death vary according to the age of the patient. The highest difference in the reported numbers in the REPACE Registry did not exceed 2 % in comparison with the National Register of Reimbursed Health Services.

Sex and age structure of patients at PM implantation (2010-2021):

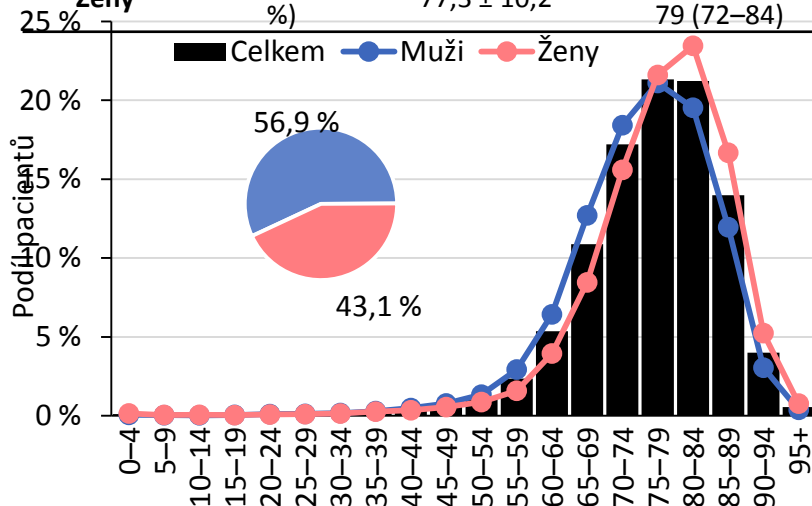
- A total of 82,791 patients underwent 1st PM implantation (47,070 males (56.9%); 35,721 females (43.1%)).
- The mean age at the time of implantation was 75.9 ± 10.4 (median 77, IQR 71-83).
- The mean age for males was 74.8 ± 10.3 (median 76, IQR 69-82).
- The mean age for females was 77.3 ± 10.2 (median 79, IQR 72-84).
- Generally, a higher proportion of pacemakers are implanted in men (56.9% vs. 43.1% in women).
- This proportion is increasing over time: in 2010, the proportion of men was 55.3%; in 2021, it is 57.8%.
- From 2010 to 2021, the average age of patients at implantation increased by 1 year from 75.3 years to 76.3 years.

Demographic characteristics of patients at the time of PM implantation

Zdroj: NRHZS 2010–2021

Pohlaví a věková struktura pacientů při primoimplantaci PM (2010–2021):

	Počet	Věk	
		průměr (SD)	medián (IQR)
Celkem	82 791	75,9 ± 10,4	77 (71–83)
Muži	47 070 (56,9 %)	74,8 ± 10,3	76 (69–82)
Ženy	35 721 (43,1 %)	77,3 ± 10,2	79 (72–84)



Vyšší podíl kardiostimulátorů je implantován u mužů (56,9 % vs. 43,1 % u žen). Tento podíl se v čase zvyšuje: v roce 2010 byl podíl mužů 55,3 %, v roce 2021 už 57,8 %.

Průměrný věk pacienta při primoimplantaci kardiostimulátoru je 76 let (75 let u mužů, 77 let u žen). Od roku 2010 do roku 2021 se průměrný věk pacientů při primoimplantaci zvýšil o 1 rok z 75,3 let na 76,3 let.

Selected patient comorbidities at 1st PM implantation (2010-2021; N = 82 791):

- Diabetes mellitus (29.1%)
- Hypertension (84.4%)
- CAD (hospitalization history/PCI/CABG) (18.7%)
- Heart failure (hospitalization history) (13.8%)
- Stroke (hospitalization history) (6.4%)
- Cancer (diagnosis in the last 5 years, malignant neoplasms except C44 - melanoma) (5.3%).

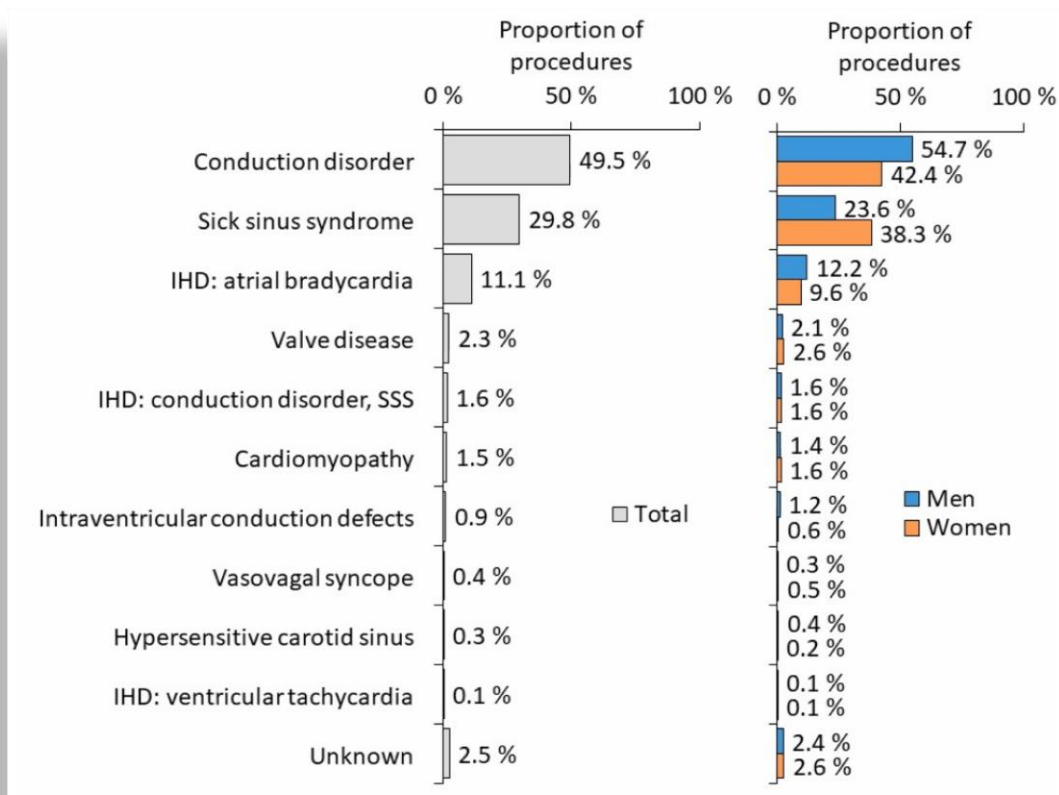
Comorbidities of patients at the time of PM implantation

Zdroj: NRHZS 2010–2021

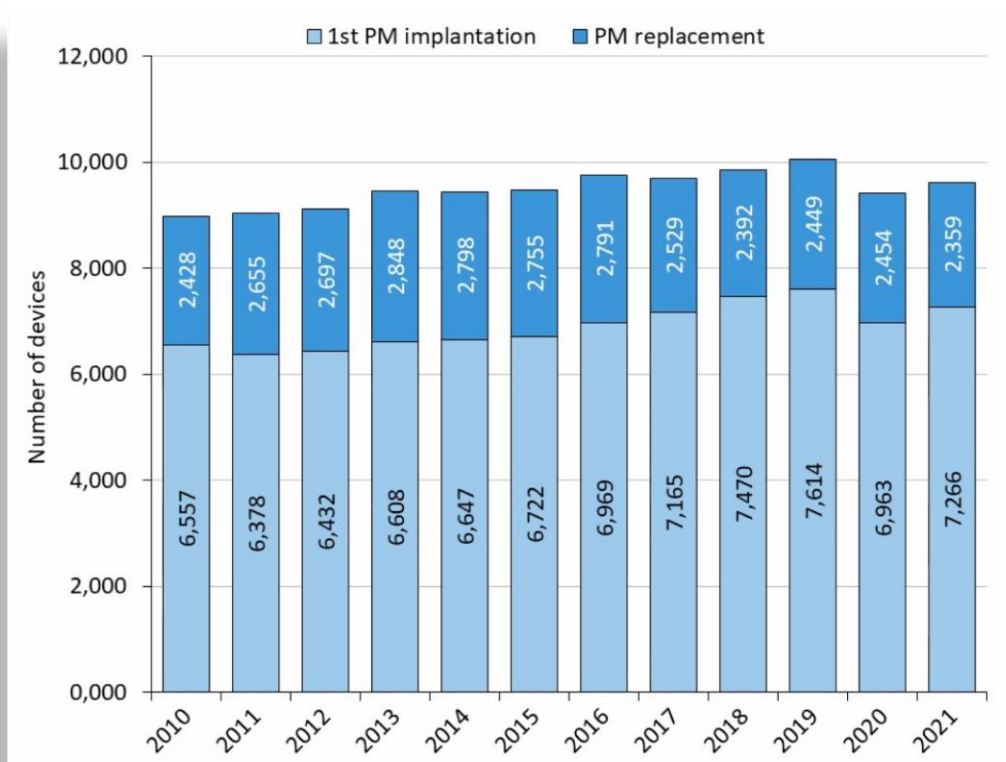
Vybrané komorbidity pacientů při primoimplantaci PM (2010–2021; N = 82 791):

Onemocnění	% z N
Diabetes mellitus	29,1 %
Hypertenze	84,4 %
Ischemická choroba srdeční (hospitalizační historie/PCI/CABG)	18,7 %
Srdeční selhání (hospitalizační historie)	13,8 %
Cévní mozková příhoda (hospitalizační historie)	6,4 %
Onkologické onemocnění (dg. v posledních 5 letech, zhoubné novotvary kromě C44)	5,3 %

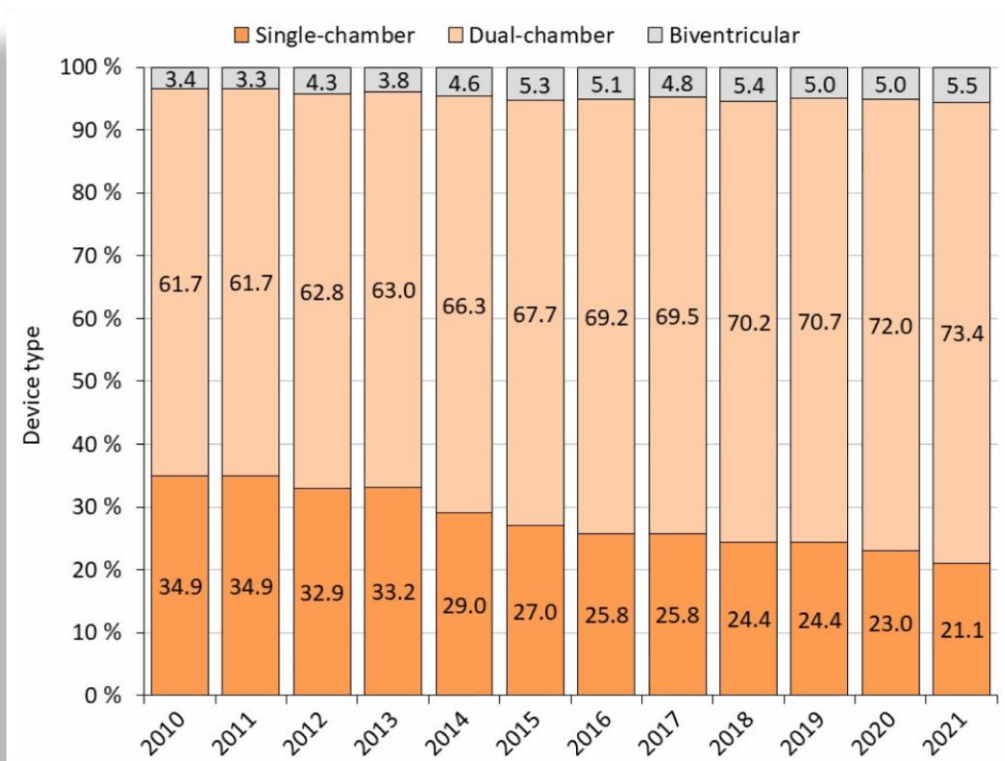
Most frequent diagnoses for pacing at the time of PM implantation according to sex



Number and type of all implanted devices 2010-2021



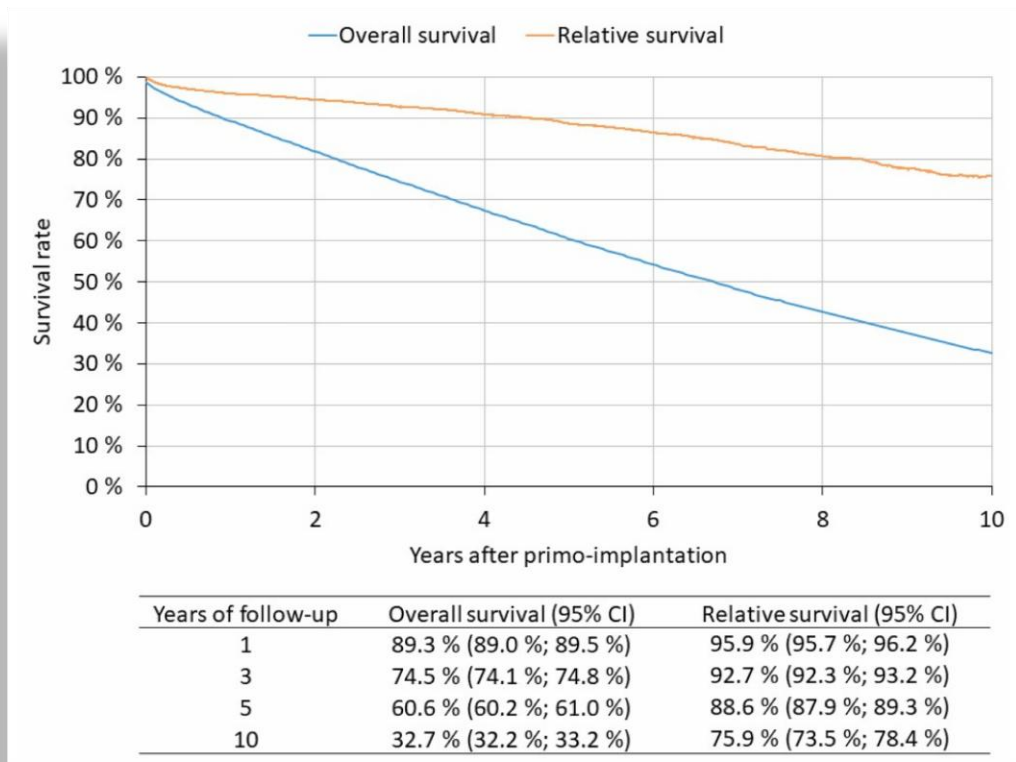
Type of implanted devices in 2010-2021



Number of pacemaker Implantation per 100,000 inhabitants and standardized to the 2013 European Standard Population (ESP)

Year	Absolute number of PM	Number per 100,000 citizens (ESP 2013)			
		PM – total	Single-chamber	Dual-chamber	Biventricular
2010	8,985	108.2	40.9	63.9	3.4
2011	9,033	105.2	38.9	63.1	3.3
2012	9,129	104.4	36.3	63.9	4.3
2013	9,456	105.6	36.6	65.1	3.9
2014	9,445	103.8	31.6	67.5	4.7
2015	9,477	102.2	28.9	68.0	5.3
2016	9,76	102.5	27.6	69.8	5.1
2017	9,694	99.7	26.9	68.2	4.6
2018	9,862	98.9	25.0	68.6	5.3
2019	10,063	99.2	25.2	69.1	4.9
2020	9,417	91.5	21.9	65.1	4.5
2021	9,625	92.5	20.3	67.1	5.1

Overall and relative survival of patients after 1st PM implantation

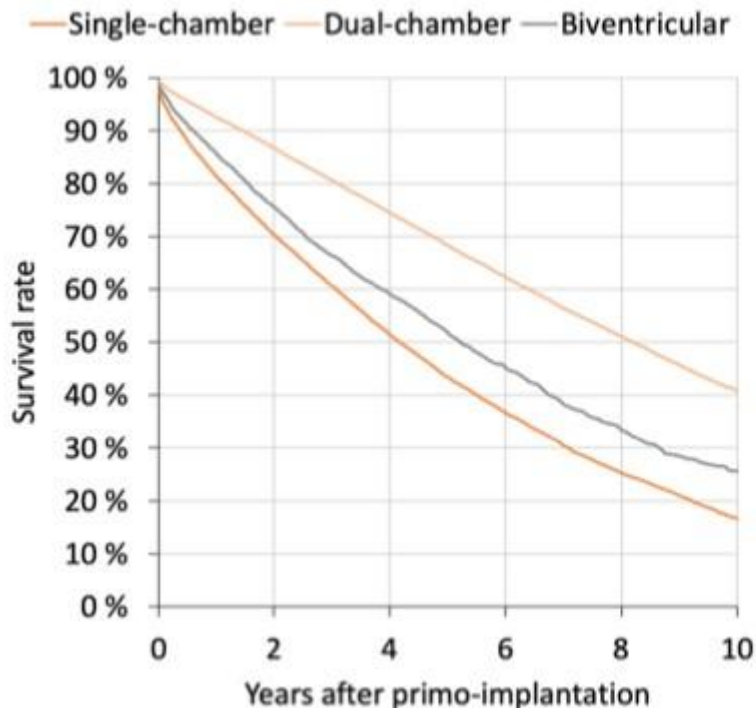


Overall survival of patients after 1st PM implantation by age

Age	Survival rate: Years after primo-implantation									
	1	2	3	4	5	6	7	8	9	10
< 50	97 %	96 %	95 %	93 %	93 %	92 %	91 %	90 %	89 %	88 %
50–54	97 %	94 %	93 %	91 %	88 %	87 %	86 %	84 %	82 %	80 %
55–59	95 %	93 %	90 %	88 %	85 %	83 %	80 %	77 %	74 %	71 %
60–64	95 %	91 %	88 %	84 %	81 %	78 %	75 %	71 %	69 %	66 %
65–69	94 %	90 %	86 %	82 %	78 %	74 %	69 %	64 %	60 %	55 %
70–74	93 %	88 %	83 %	77 %	72 %	67 %	61 %	56 %	50 %	44 %
75–79	91 %	85 %	78 %	71 %	64 %	57 %	50 %	44 %	37 %	31 %
80–84	88 %	78 %	70 %	61 %	52 %	43 %	35 %	28 %	22 %	16 %
85–89	82 %	69 %	57 %	46 %	36 %	27 %	20 %	14 %	10 %	6 %
90+	69 %	53 %	40 %	27 %	18 %	12 %	8 %	4 %	2 %	2 %

100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %

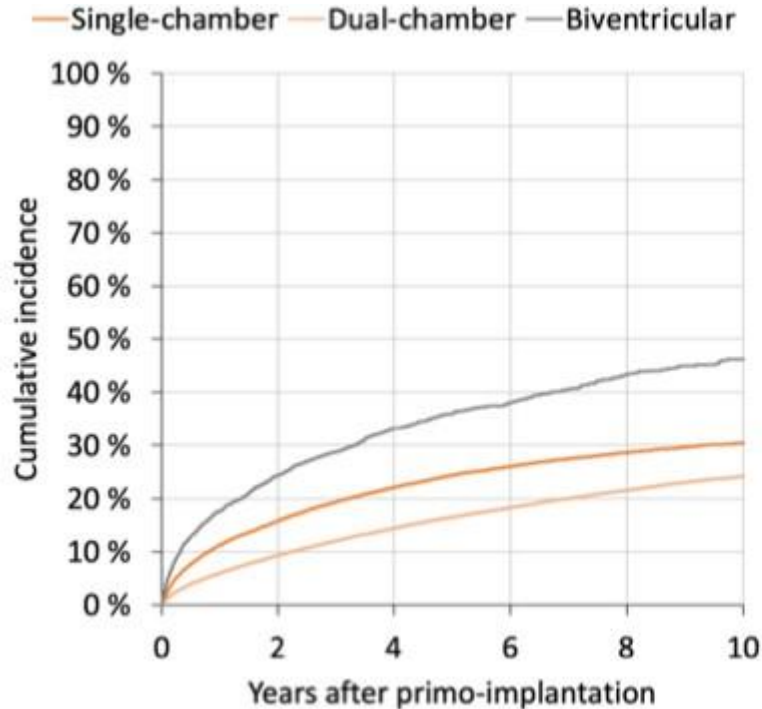
10-year survival of patients according to type of pacing



Years	Probability of overall survival (95% CI)
Single-chamber (N = 22,372)	
1	81.3 % (80.8–81.9 %)
5	43.5 % (42.7–44.2 %)
10	16.7 % (15.9–17.4 %)
Dual-chamber (N = 57,472)	
1	92.6 % (92.3–92.8 %)
4	68.3 % (67.8–68.7 %)
5	40.7 % (40.0–41.4 %)
Biventricular (N = 2,943)	
1	85.6 % (84.3–86.9 %)
5	51.8 % (49.7–53.9 %)
10	25.6 % (23.1–28.2 %)

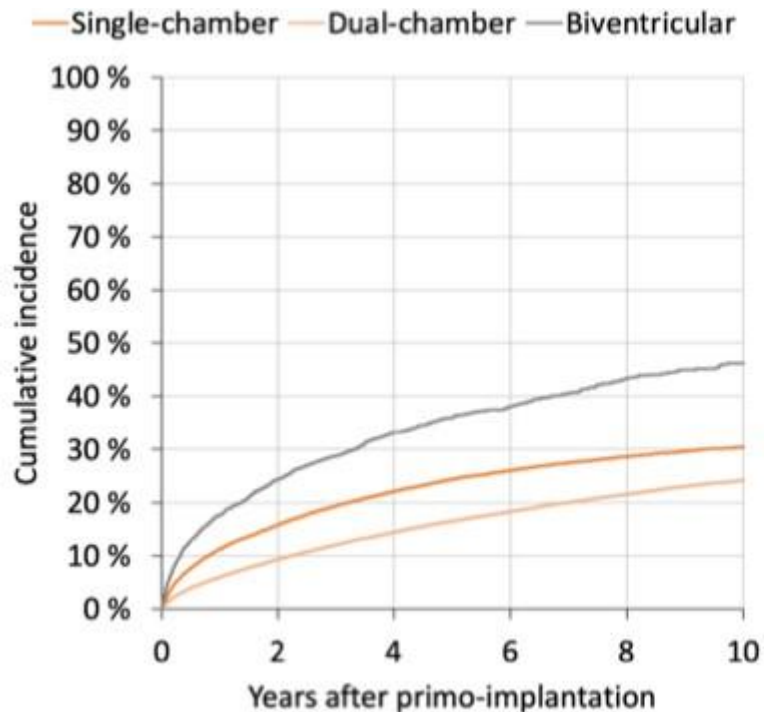
Pozn: Adjustováno na evropskou populaci

Overall survival of patients after 1st PM implantation according to the pacemaker type



Years	Probability of hospitalization for heart failure (95% CI)
Single-chamber (N = 22,372)	
1	11.3 % (10.9–11.7 %)
5	24.4 % (23.8–25.0 %)
10	30.5 % (29.8–31.2 %)
Dual-chamber (N = 57,472)	
1	6.0 % (5.8–6.2 %)
4	16.5 % (16.2–16.9 %)
5	24.3 % (23.8–24.8 %)
Biventricular (N = 2,943)	
1	17.7 % (16.3–19.1 %)
5	36.0 % (34.1–37.9 %)
10	46.3 % (43.8–48.7 %)

Cumulative incidence of hospitalizations for heart failure in patients after 1st PM implantation according to the pacemaker type



Years	Probability of hospitalization for heart failure (95% CI)
Single-chamber (N = 22,372)	
1	11.3 % (10.9–11.7 %)
5	24.4 % (23.8–25.0 %)
10	30.5 % (29.8–31.2 %)
Dual-chamber (N = 57,472)	
1	6.0 % (5.8–6.2 %)
4	16.5 % (16.2–16.9 %)
5	24.3 % (23.8–24.8 %)
Biventricular (N = 2,943)	
1	17.7 % (16.3–19.1 %)
5	36.0 % (34.1–37.9 %)
10	46.3 % (43.8–48.7 %)

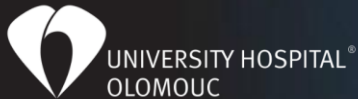
Results I

- The highest difference in the reported numbers in the *REPACE* Registry did not exceed 2 % in comparison with the *National Register of Reimbursed Health Services*.
- In Czech patients, the annual number of PM implantations has been steadily increasing slightly (on average 120 cases per year between 2010 and 2019).
- Gradual increase in the number of patients can be explained by the ageing of the population.
- From 2010 to 2021, the average age of patients at implantation increased by 1 year from 75.3 years to 76.3 years. T
- Gradual ageing of the population and the corresponding increase in the number of PMs is also evident in other countries .
- In 2021, 9,625 PMs were implanted in the Czech Republic, which corresponds to 91.46 PMs per 100,000 inhabitants.

Results II

- Total implantation numbers per 100,000 inhabitants vary in Europe widely, from Germany (196.53 per 100.000 inhabitants) to Kosovo (2.81 per 100.000 inhabitants).
- Higher implantation numbers correlate moderately with a higher GDP and higher health expenditure.
- Czech Republic is somewhere in the middle and is similar to Spain (95.3 per 100.000 inhabitants) and Luxembourg (91.7 per 100.000 inhabitants).
- The worst survival rate had patients with single-chamber PM, patients with CRT-P had a slightly better survival rate; patients with dual-chamber had the best survival rate
- Patients in the National Register of Reimbursed Health Services and the REPACE registry are not directly linked → change in 2024

Thank you for your attention
Olomouc University Hospital



Faculty of Medicine
and Dentistry

Palacký University
Olomouc



Results

- Retrospective observational analysis of pacemakers' implantation in all Czech patients (n=82,791; 47,070 (56.9%) men, 75.9 ± 10.4 years old) between 2010 and 2021. Almost 114,000 pacemakers were implanted between 2010 and 2021, of which 27.9% were single-chamber, 67.4% were dual-chamber and 4.6% were biventricular.
- The annual number of implantations has been steadily increasing with a 6% annual decline in 2020 with increased mortality and reductions in care provided, likely related to COVID-19.
- The observed 5-year relative survival was 88.6% (overall survival 60.6%) and the 10-year relative survival was 75.9% (overall survival 32.7%).
- Causes of death vary according to the age of the patient.
- The highest difference in the reported numbers in the REPACE Registry did not exceed 2 % in comparison with the National Register of Reimbursed Health Services.