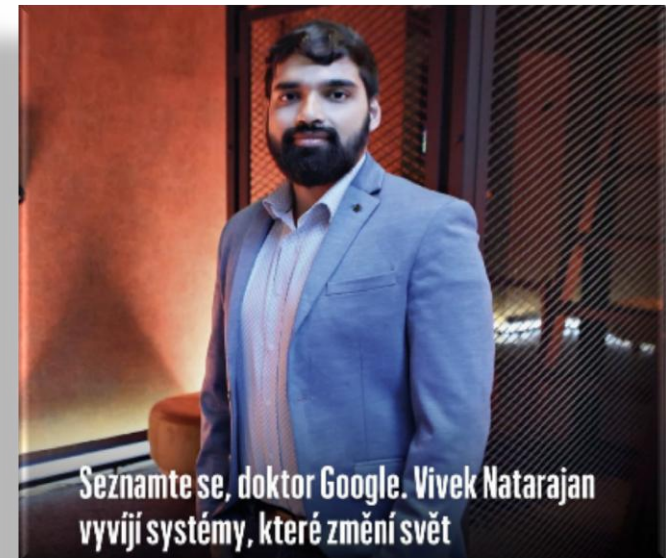


# KV prevence ve světě digitalizované medicíny a umělé inteligence

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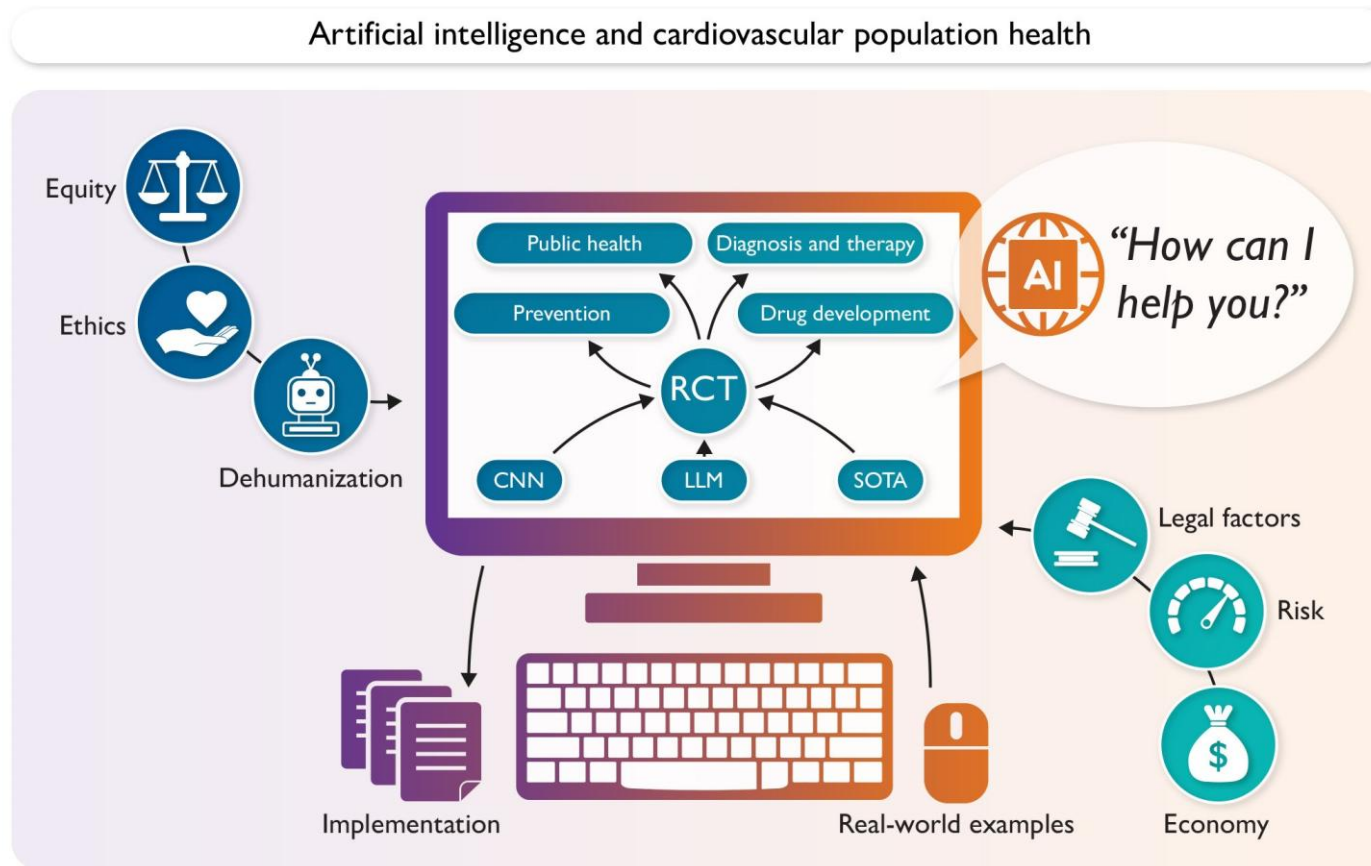
# Úvod:

- Kardiologové by měli být **informováni o nových algoritmech AI**, které mohou zlepšit jejich klinický pracovní postup, ať už prostřednictvím **přesnějšího hodnocení individuálního rizika KVO u pacientů**, pochopení překážek při poskytování péče, nebo prezentace **automatizovaného hodnocení markerů kardiovaskulárního rizika**.
- **Zjednodušený přístup k používání AI v preventivní kardiologii** by měl zahrnovat pokračující zdokonalování těchto algoritmů strojového učení, provádění prospektivních hodnocení zkoumajících použití AI modelování a přístup k integrovaným klinickým nástrojům v systémech zdravotní péče.

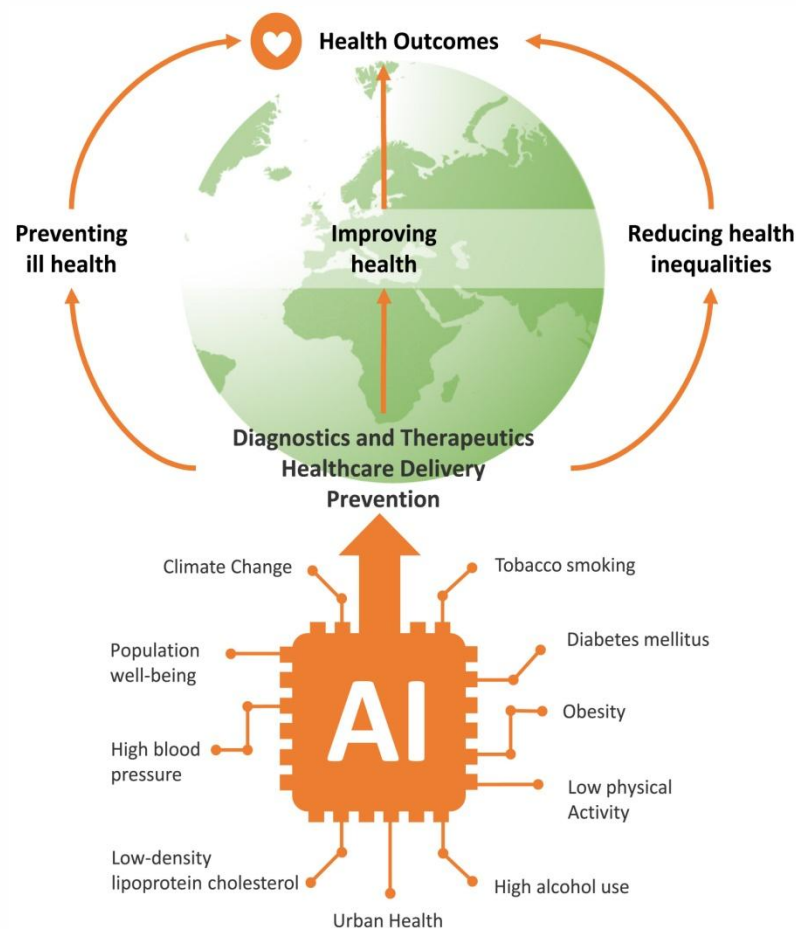
# KV úmrtí celosvětově 2021

Rank	Cause of death	Number of deaths in 2021	Number of DALYs
1	Ischaemic heart disease	9 440 000	185 000 000
2	Ischaemic stroke	3 870 000	70 200 000
3	Intracerebral haemorrhage	3 460 000	78 600 000
4	Hypertensive heart disease	1 410 000	24 900 000
5	Rheumatic heart disease	391 000	13 400 000
6	Atrial fibrillation and flutter	366 000	8 200 000
7	Subarachnoid haemorrhage	365 000	10 400 000
8	Cardiomyopathy	320 000	8 450 000
9	Other cardiovascular diseases	232 000	10 100 000
10	Aortic aneurysm	160 000	3 040 000

# State-of-the-art review addresses the use of artificial intelligence (AI) in promoting public health

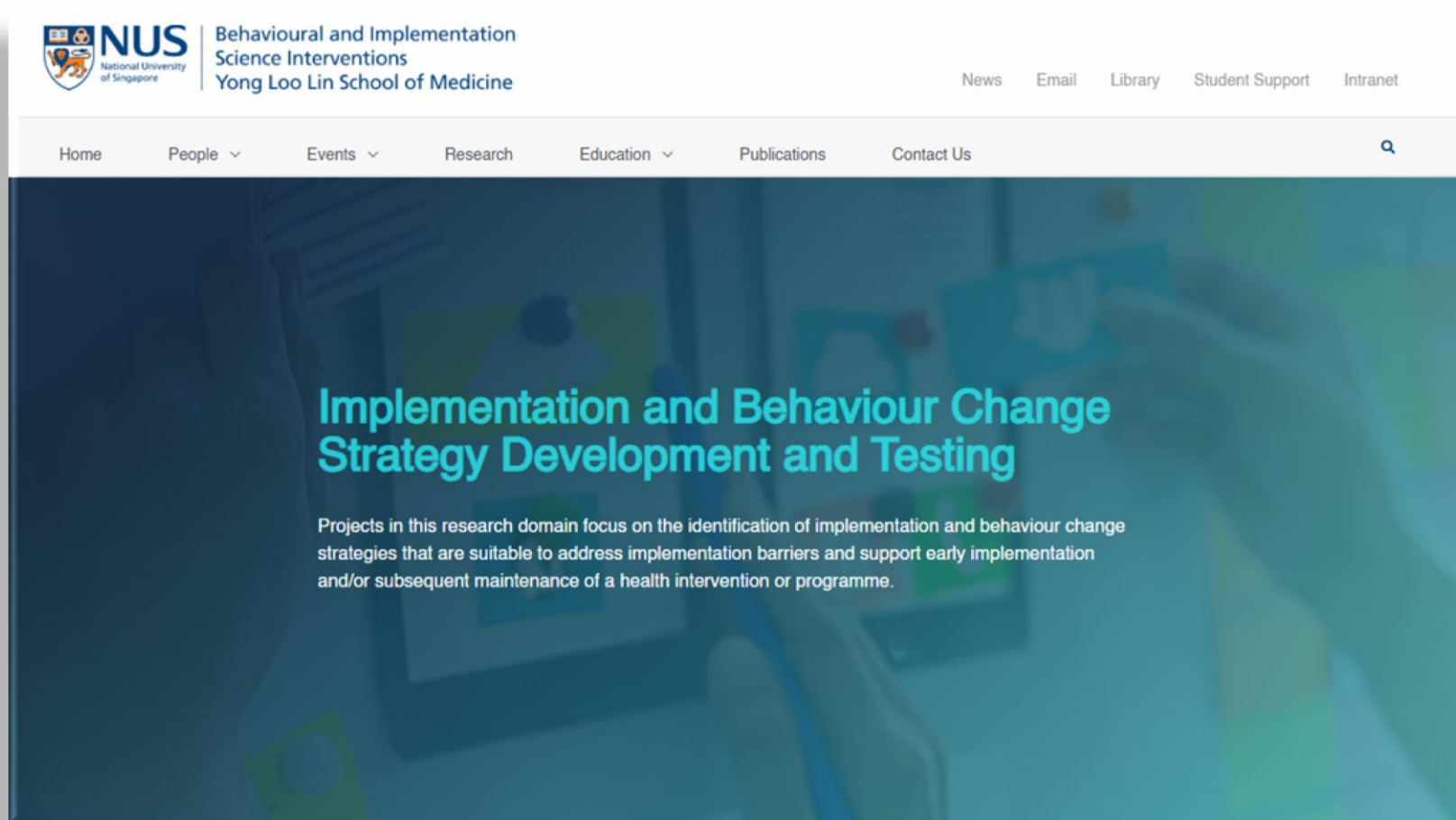


# Artificial intelligence improves or enables preventive strategies for several risk factors, comorbidities



Oblasti KV prevence, kde může být  
AI zásadním krokem ke zlepšení...

# AI v komplexním pohledu na strategii řízení péče



[Research - Implementation and Behaviour Change Strategy Development and Testing - Behavioural and Implementation Science Interventions \(BISI\)](#)

Singapur

# 1. Physical activity: addressing the growing challenge

- Alarmingly, inadequate physical activity is linked to an estimated 397 000 cardiovascular deaths and 686 000 all-cause deaths annually.
- In countries like Germany and the USA, some health insurers support the use of smartwatches and digital health applications through initiatives like the Digital Supply Act (DiGA; <https://diga.bfarm.de/de>), which enables prescribing medical-grade exercise planning, rehabilitation, and prevention programmes for conditions such as diabetes, obesity, and smoking cessation.
- Recent study by Dergaa *et al.* evaluated OpenAI's GPT-4 LLM for personalized exercise prescription

## 2: Obesity and diabetes

- AI has made significant strides in the research and treatment of metabolic disorders like diabetes, also linked to obesity.
- From predicting the onset of diabetes and classifying its subtypes to managing modifiable risk factors and optimizing nutrition therapy, AI is currently transforming diabetes care.
- Many glucose monitoring devices and insulin pumps now incorporate AI algorithms to calculate optimal insulin doses or adjust oral anti-diabetic medication more precisely.

# 3: Artificial intelligence for hypertension and lipid management

- AI offers promising solutions for both the management and prediction of hypertension.
- Digital tools are well-suited to monitor blood pressure and improve adherence to treatment plans, while AI can go a step further by predicting the onset of hypertension and individual responses to specific antihypertensive medications.
- AI has also demonstrated superior performance in diagnosing and managing hyperlipidaemia, particularly in predicting diagnostic markers using electronic health records.

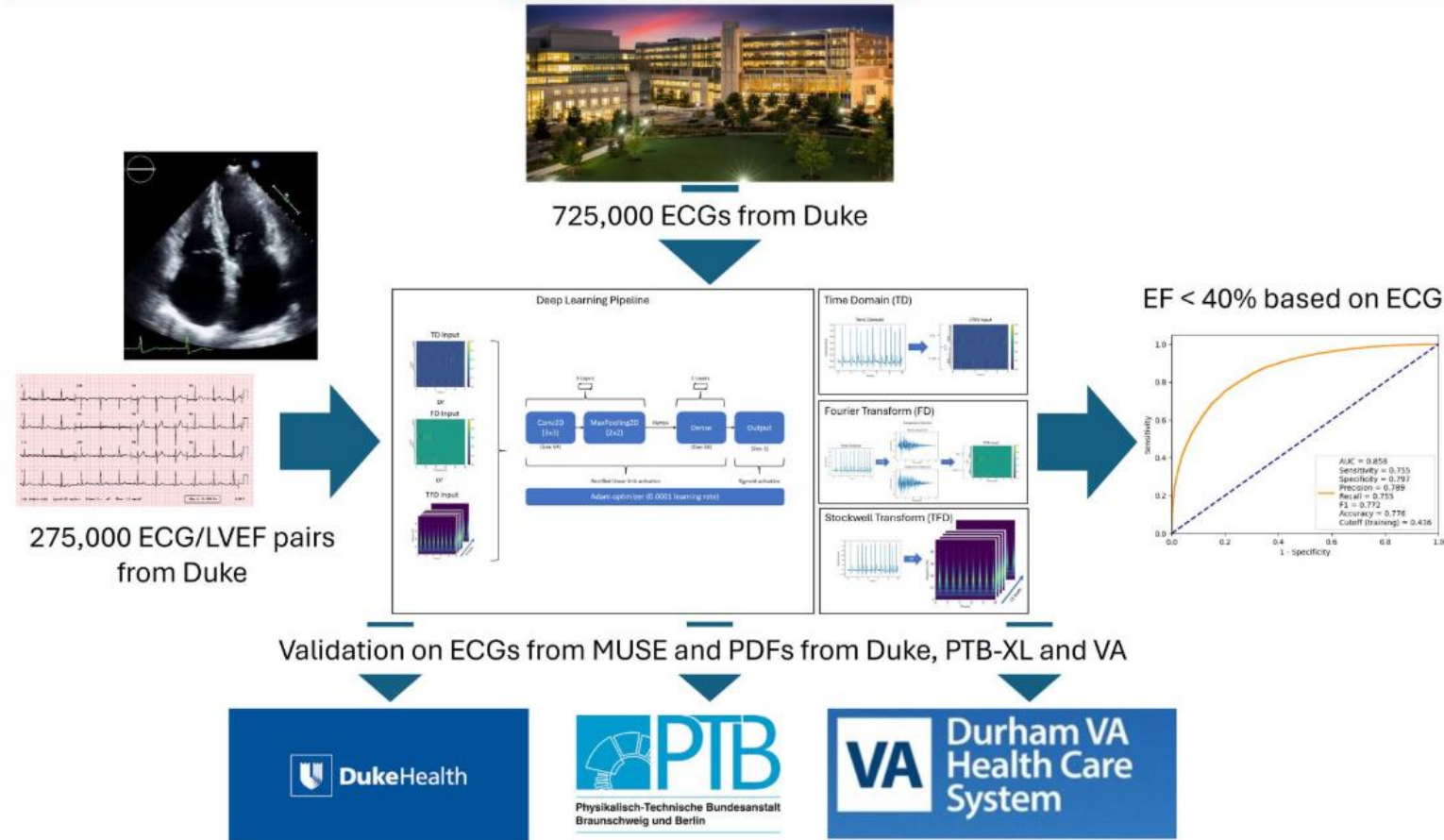
# 4: Can artificial intelligence stop tobacco and high alcohol use?

- In Germany, the Digital Healthcare Act (2020) allows doctors to prescribe certified health apps that support patients in managing diseases or prevention strategies.
- Smoking cessation apps are among the most frequently prescribed, highlighting the potential of digital tools to overcome traditional barriers like scheduling difficulties, time constraints, and personal discomfort in clinical settings.
- For instance, natural language processing techniques can be used to analyse unstructured data in electronic health records and identify patterns indicative of alcohol-related health risks.

# 5: Climate change, urban health, and exposome modelling by artificial intelligence

- Over the past three decades, there has been a global shift in morbidity and mortality from infectious diseases to non-communicable diseases like CVD.
- Air pollution remains a leading cause of global and cardiovascular mortality, with little improvement on the horizon.
- Urban risk factors such as noise and light pollution also contribute significantly to CVD; in principle, these are preventable through technical interventions and regulatory measures.

# 6:AI based stanovení rizika srdečního selhání ( fenotypu HFrEF)



# Jeden z modelů KV prevence s robustními daty

- **Most ECG-AI models are brittle to real-world shift**
- **Fourier-domain representations improve robustness across XML and PDF-derived ECGs**
- **Saliency mapping shows preserved interpretability through stable spectral features**
- **This enables scalable inference from archived ECGs across health systems**

PREDICTED CLINICAL IMPACT OF AI-ECG EF SCREENING (PER 1,000 PATIENTS)

Threshold	Model & Source	Sens (%)	TTEs Avoided	Cases Missed	NNS
10%	AI XML (Fourier)	99.8	378	1	2
	AI PDF (Fourier)	96.1	111	20	2
	AI PDF (Real Time)	99.3	96	4	2
20%	AI XML (Fourier)	99.6	403	2	2
	AI PDF (Fourier)	94.5	203	28	2.1
	AI PDF (Real Time)	98.1	183	10	2

# 7: Fenotypizace pacientů s HFpEF : Riziko vzniku FS

## Purpose

- To perform multimodal atrial phenotyping in HFpEF by integrating electrical, structural, functional, and biochemical markers for atrial cardiomyopathy
- To compare patients with and without clinical manifest AF and assess exercise performance and functional echo parameters during stress

## Methods

- Retrospective analysis of 153 HFpEF patients (61 with AF, 91 without AF)
- Analysis of electronic health record data for clinical and lab parameters, left atrial function: LAVI, LAEF, LASr at rest and during stress echo (n=69)
- Assessment of electrical cardiomyopathy markers in sinus rhythm ECGs (n=99): P-wave amplitude, duration, dispersion, PTFV1
- Investigation of cardiopulmonary exercise performance in both groups
- Correlation-, cluster- and principal component analysis (PCA) for atrial phenotyping.

## Results

- Clinical AF (45% paroxysmal, 40% persistent) was associated with significantly reduced LAEF and LASr (both p<0.001) in HFpEF patients (Tbl. 1).
- Subclinical atrial dysfunction was prevalent in patients without AF (pathological LASr in 52%, pathological LAEF in 40%) (Tbl.1).
- LASr did not increase with exercise, indicating impaired atrial functional reserve (Figure A).
- Exercise capacity was markedly reduced and did not differ between groups (Figure C).
- Cluster analysis did identify discrete atrial phenotypes (Figure B).
- PCA revealed two dimensions of atrial remodelling (39% of total variance):
  - Functional-electrical axis (PC1, 22%): LAEF, LASr, P-wave amplitude
  - Structural/load axis (PC2, 17%): LAVI, NT-proBNP, P-wave dispersion

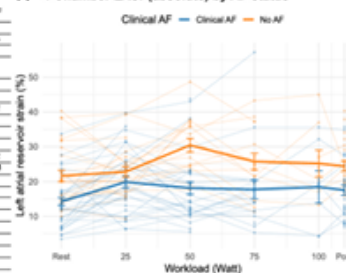
## Conclusion

- HFpEF is associated with pronounced atrial remodelling consistent with atrial cardiomyopathy, irrespective of clinically manifest AF. This may confer thromboembolic risk/anticoagulation need independent of AF status in HFpEF patients.
- LASr during exercise is more reduced in AF vs. non-AF patients at rest and most exercise levels.
- No distinct atrial phenotypes emerged, underscoring substantial pathophysiological heterogeneity in HFpEF.
- Larger studies with integrated, multimodal atrial assessment may refine phenotyping and improve risk stratification.

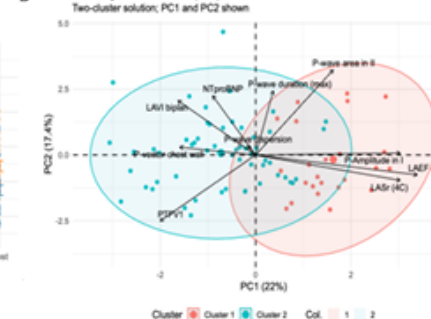
	N	No AF (n = 61)	AF Status Clinical AF (n = 92)	p value <sup>a</sup>
Gender (women)	153	37 (60%)	39 (42%)	0.2
Age (years)	153	71 ± 9	74 ± 6	0.265
BMI (kg/m <sup>2</sup> )	153	27.7 ± 4.2	28.9 ± 5.8	0.5
Preexisting condition	153			
AF				
paroxysmal		0 (0%)	37 (40%)	<0.5
persistent		0 (0%)	39 (42%)	
DiI	152	28 (46%)	26 (27%)	0.050
DiII	152	55 (90%)	82 (89%)	<0.5
Hyperlipidemia	150	45 (75%)	57 (62%)	0.13
DiSD	150	37 (62%)	42 (45%)	0.2
DiP	153	4 (6%)	24 (26%)	0.000
NT-proBNP (ng/l)	153	650 ± 1,093	930 ± 956	<0.001
Walking distance (m)	149	412 ± 115	404 ± 117	0.8
CRAB/STRA	151	4 (8%)	7 (7%)	0.99
< 2		57 (88.4%)	63 (68.3%)	
≥ 2		6 (9.6%)	14 (15.2%)	
max. Watt (W) in SE	141	86 ± 25	88 ± 34	0.7
Peak VO <sub>2</sub> (l/min)	141	15.4 ± 3.4	15.8 ± 4.8	0.6
Predicted peak in SE (W)	153	115.9 ± 58.9	120.7 ± 52.7	0.8
% of predicted SE-peak	141	65.4 ± 43.2	70.8 ± 33.6	0.4
Stress echo evaluated	71	31 (51%)	40 (43%)	0.4
Peak LASr (s)	64	26 ± 15	26 ± 11	0.815
Absolute change to rest (s)	63	4 ± 12	5 ± 8	0.7
%-change to rest (s)	63	21 ± 52	37.2 ± 70.8	0.028
Stress-testing HC LASr:				
Rest	69	22 ± 9	14 ± 7	0.001
25W	63	28 ± 7	20 ± 9	0.2
50W	65	32 ± 8	18 ± 10	<0.001
75W	35	26 ± 10	18 ± 12	0.003
100W	16	25 ± 11	18 ± 12	0.3
Recovery	63	24 ± 7	18 ± 8	0.003
LAEF (s)	132	50 ± 13	36 ± 14	<0.001
LAEF (s) Status	132			<0.001
normal	47	28 (60%)	19 (24%)	
reduced	85	18 (40%)	61 (76%)	
LASr (s) Status	153			<0.001
normal	29	18 (62%)	19 (21%)	
reduced	32	12 (38%)	73 (79%)	
max. sys BP	76	168 ± 30	148 ± 34	0.016
max. dia. BP	76	87 ± 16	78 ± 13	0.003

Table 1: Comparative summary of demographic, clinical, functional, and echocardiographic characteristics of patients with HFpEF, divided by presence or absence of atrial fibrillation. Statistical significance of differences between groups is shown with p-values.

## A 4-Chamber LASr (absolute) by AF status



## B PCA Biplot – Electrical, LA, and BNP Parameters



## C Exercise Capacity by Atrial Fibrillation Status

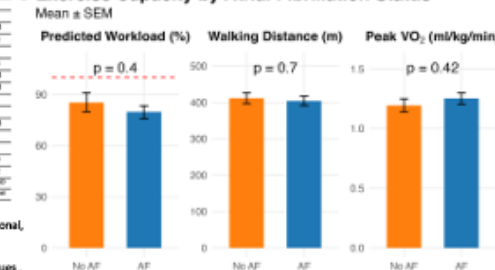


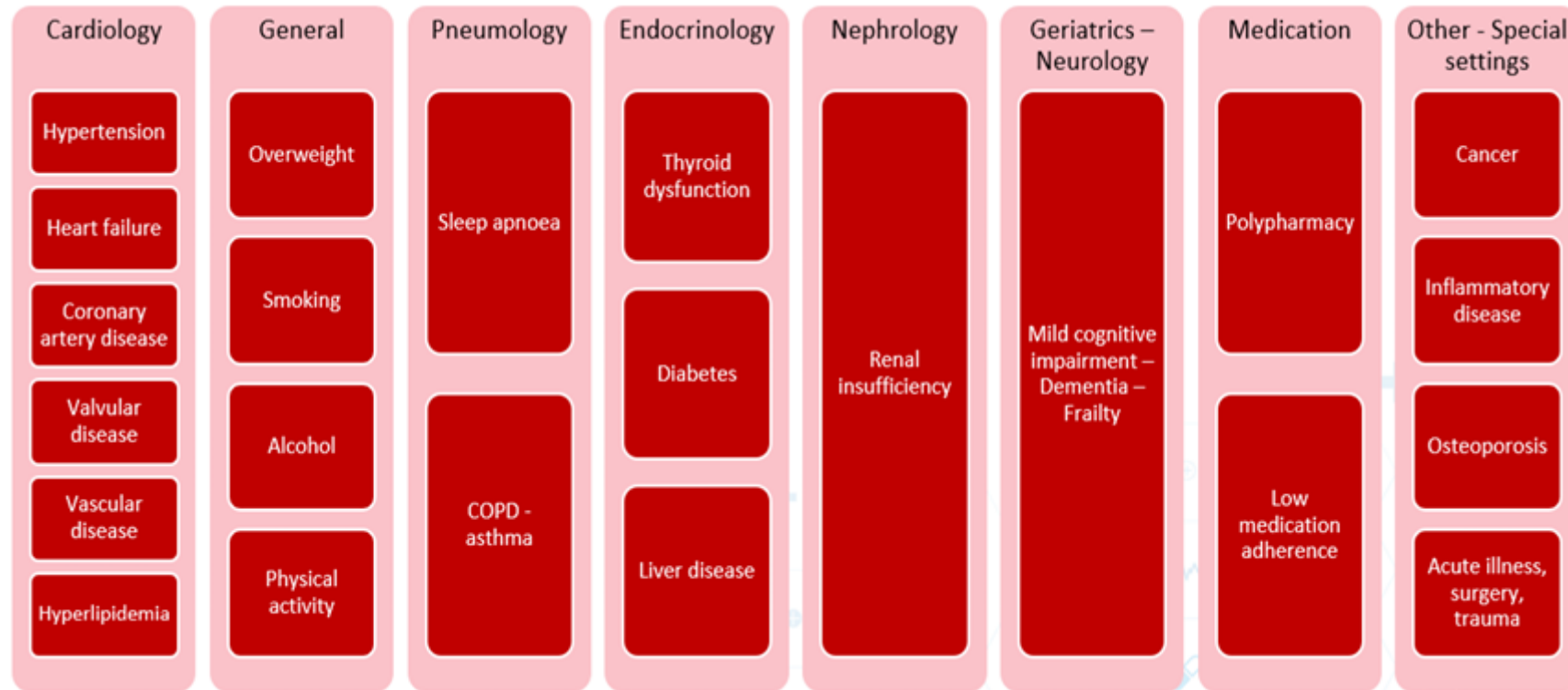
Figure 1:

A: Comparison of atrial strain development in stress echocardiography depending on power (in watts) between HFpEF patients with (blue) and without (orange) atrial fibrillation.  
 B: Principal component analysis (PCA) of electrical, echocardiographic parameters and NT-pro-BNP values, k-means analysis revealed two clusters.  
 C: Exercise capacity in patients with and without atrial fibrillation. Predicted workload (%), walking distance (m), and peak VO<sub>2</sub> (ml/kg/min) are shown as mean ± SEM. No significant differences were observed between groups (unpaired t-test).

# 8: Artificial intelligence in drug development

- During the COVID-19 pandemic, companies like BioNTech and Moderna utilized AI algorithms to optimize vaccine discovery, sequence optimization, and trial design, expediting the development of effective vaccines
- Artificial intelligence has also been instrumental in drug discovery and target modelling, with platforms like AlphaFold2 revolutionizing our understanding of protein structures.
- AI is employed in toxicity prediction, dosage estimations, pharmacodynamics, pharmacokinetics, trial design, and data interpretation from large-scale interventional studies.

# 9: Nový pohled na komplexní léčbu : EHRA-PATHS : AI Design of new care pathways 23 cardiovascular and non-cardiovascular comorbidities



# Legislativní a organizační aspekty AI pro běžnou klinickou praxi

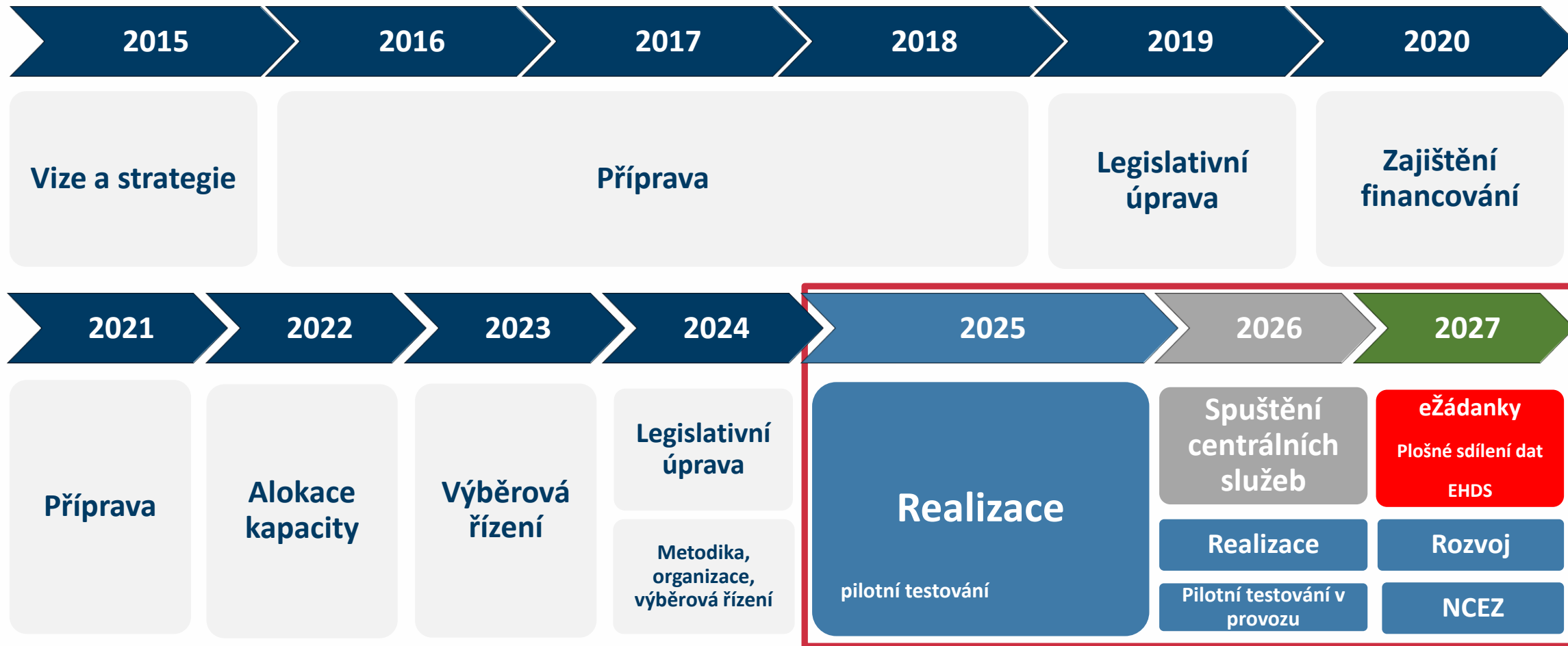
# EU AI Act vstoupil v platnost 1. srpna 2024

- AI Act je nové nařízení Evropské unie, které stanovuje jednotná pravidla pro vývoj, dovoz, uvádění na trh a používání některých systémů umělé inteligence a pro modely umělé inteligence.
- Jako nařízení EU je AI Act v Česku přímo použitelný a má sílu zákona.
- Týká se firem, organizací a institucí které umělnou inteligenci vyvíjí, dováží nebo používají.



[Nařízení Evropského parlamentu a Rady \(EU\) 2024/1689 ze dne 13. června 2024, kterým se stanoví harmonizovaná pravidla pro umělou inteligenci a mění nařízení \(ES\) č. 300/2008, \(EU\) č. 167/2013, \(EU\) č. 168/2013, \(EU\) 2018/858, \(EU\) 2018/1139 a \(EU\) 2019/2144 a směrnice 2014/90/EU, \(EU\) 2016/797 a \(EU\) 2020/1828 \(akt o umělé inteligenci\)](#)Text s významem pro EHP.

# Harmonogram, časová osa realizace Digitalizace zdravotnictví v ČR 2015-2027



# Digitalizace zdravotnictví a rozvoj 2026 - 2030

## Národní centrum elektronizace zdravotnictví (NCEZ) v roce 2026/2027

- Institucionalizace od 2026+

### Projekty elektronizace a digitalizace v roce 2026

Jsou nezbytným základem – vytvářejí infrastrukturu, na které lze teprve stavět skutečnou transformaci zdravotnictví.

### Implementace a reálné využití 2026 - 2030

Skutečný přínos elektronizace spočívá ve schopnosti dosáhnout širokého, efektivního a každodenního využití v praxi napříč celým systémem zdravotní péče.



Zajištění kontinuity  
centrálních projektů,  
interoperability a  
rozvoje telemedicíny



Legislativní a  
implementační  
připravenost na EHDS  
(do roku 2028)



Strategické uchopení  
oblasti umělé  
inteligence ve  
zdravotnictví



Posílení kybernetické  
bezpečnosti v souladu s  
legislativou NIS2

# Co nás nepochybně čeká: Google DeepMind

- In July 2016, a collaboration between DeepMind and Moorfields Eye Hospital was announced to develop AI applications for healthcare.
- DeepMind would be applied to the analysis of anonymised eye scans, searching for early signs of diseases leading to blindness.
- DeepMind developed an app called Streams, which sends alerts to doctors about patients at risk of acute kidney injury.
- On 13 November 2018, DeepMind announced that its health division and the Streams app would be absorbed into Google Health...

# Souhrn:

- Umělá inteligence má obrovský potenciál pro preventivní medicínu, pomáhá lékařům při rozhodování na základě dat tím, že poskytuje rychlé informace pro diagnózu a léčbu.
- Může vylepšit personalizovanou péči prostřednictvím individuálně šitých doporučení pro léky, výživu, regulaci hmotnosti a fyzickou aktivitu.
- V lékařském výzkumu umožňuje umělá inteligence analýzu rozsáhlých datových sad a vývoj inovativních metodologií.
- Jednou z obzvláště transformativních oblastí je využití generativní umělé inteligence, zejména modelů s velkými jazyky (LLM), které mají potenciál způsobit revoluci ve zdravotnictví, lékařském vzdělávání i výzkumu...

# Děkuji vám za pozornost



*Mies van der Rohe, Vila Tugendhat, Brno, 1929 -1930.*