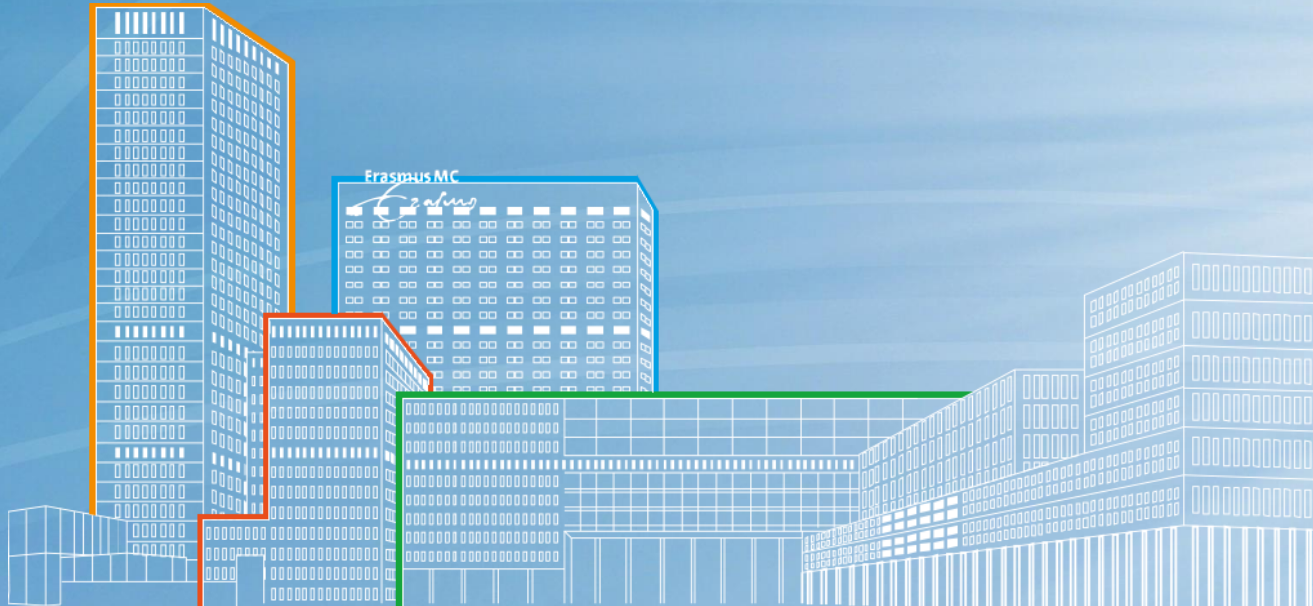


Monitoring heart failure patients

Dr. Jasper Brugts





Monitoring Heart Failure Patients

Dr. J. J. Brugts, cardioloog Erasmus MC

Disclosures

Sponsoring

Geen

Research funding

Independent research grants Abbott to Institute

Honoraria (advisory/speaker fees, 5 jr.)

Abbott, Astra Zenica, Bayer, Boehringer, Novartis, Vifor

Aandeelhouder

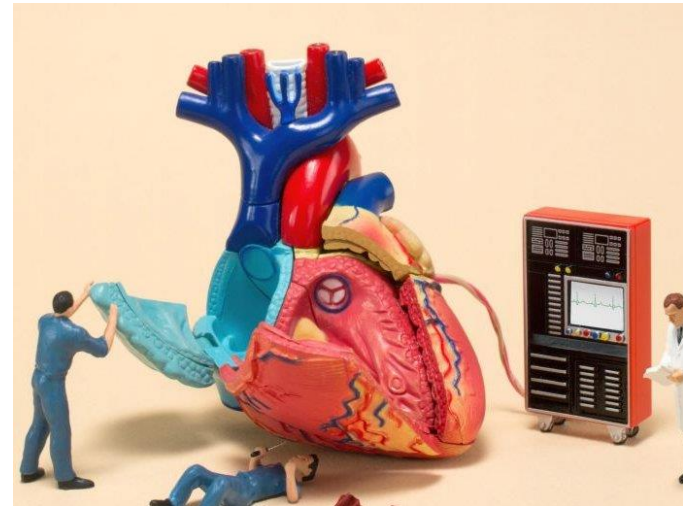
Geen

Andere relatie, namelijk ...

Geen

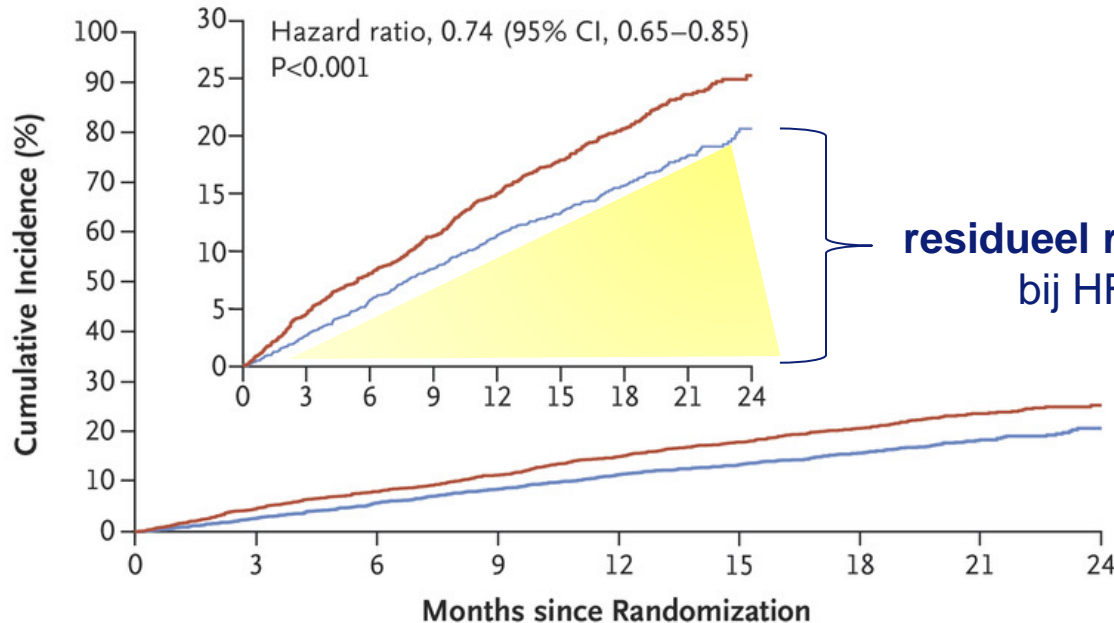
Chronisch Hartfalen

- 2022: 240.000 patiënten met de diagnose hartfalen, 90% >65 jr ⁽¹⁾
- 2030: 340.000 patiënten met de diagnose hartfalen
- Snelle toename door vergrijzing, primaire PCI, en CV risicofactoren
- 35.000 HF opnames per jaar
 - gemiddelde ligduur 8 dagen



⁽¹⁾ www.hartstichting.nl Hart- en Vaat cijfers 2022

Vier pilaren GDMT, zijn we er dan al?



No. at Risk

	0	3	6	9	12	15	18	21	24
Placebo	2371	2258	2163	2075	1917	1478	1096	593	210
Dapagliflozin	2373	2305	2221	2147	2002	1560	1146	612	210

Hartfalen en het ziekenhuis



*Hoe houden we patiënten
uit het ziekenhuis?*

*Kan er ook HF zorg plaats-
vinden buiten het ziekenhuis?*

Beschikbare vormen van telemonitoring

- Non-invasief
- Invasief
 - ICD/PM
 - Sensoren

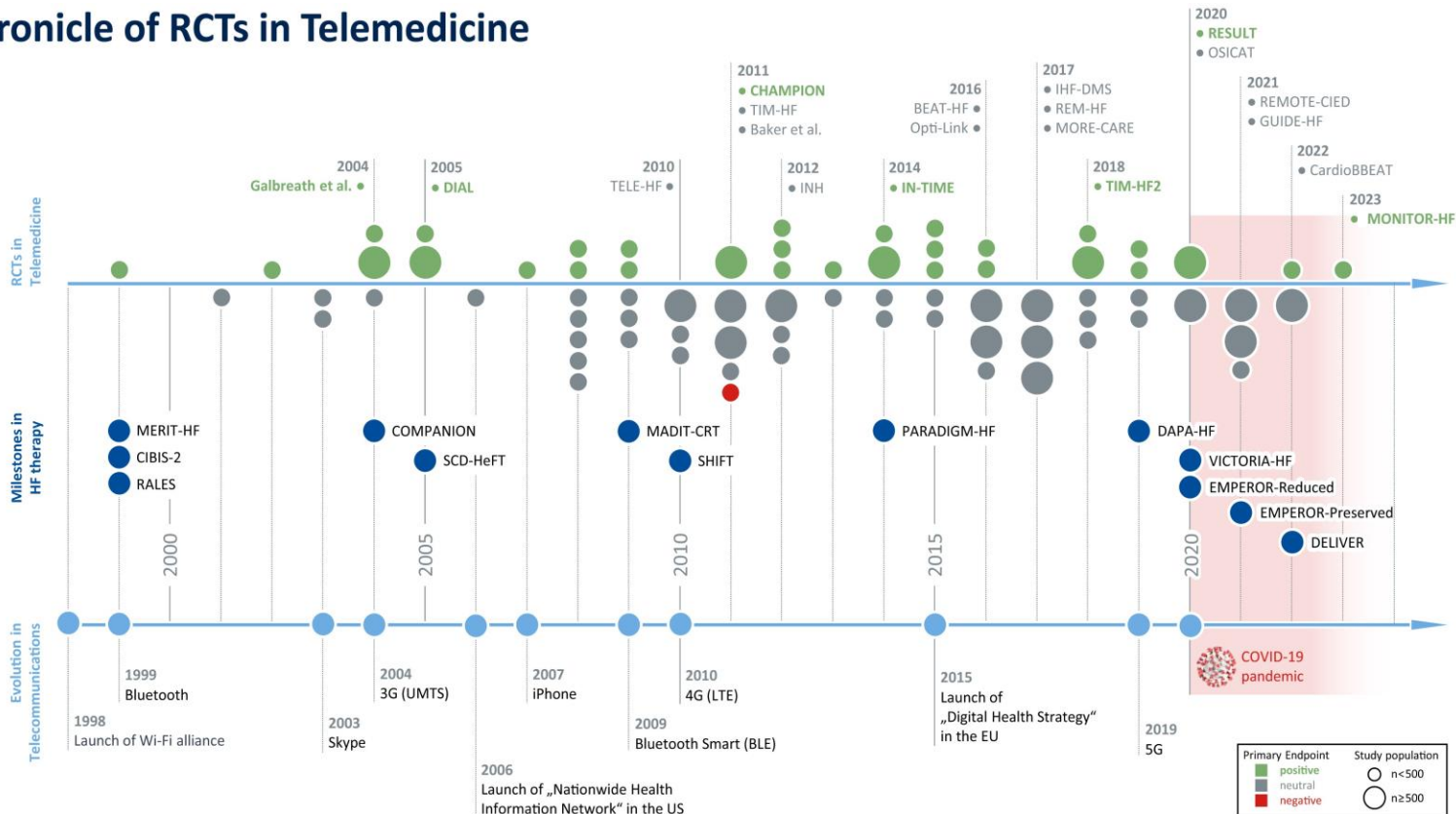


Telemonitoring heart failure: >3.000.000 hits

Telemonitoring app: >2.000.000 hits

Telemonitoring bij chronisch hartfalen

Chronicle of RCTs in Telemedicine



Meta-analysis telemonitoring for heart failure patients

Non-invasive home telemonitoring systems



Telemonitoring

Modality in which biometric data and/or health related questionnaires are collected and sent to an HF clinic.



Structured Telephone Support

Modality in which HF patients are called by a HF nurse or cardiologist on a frequent basis.



Complex Telemonitoring

Modality in which multiple TM is combined with STS and/or 24h-call center or mix of other sub-modalities.

Invasive home telemonitoring systems



Cardiac Implantable Devices

Modality in which PM/ICD systems (optionally with impedance leads) are used to monitor the patient.

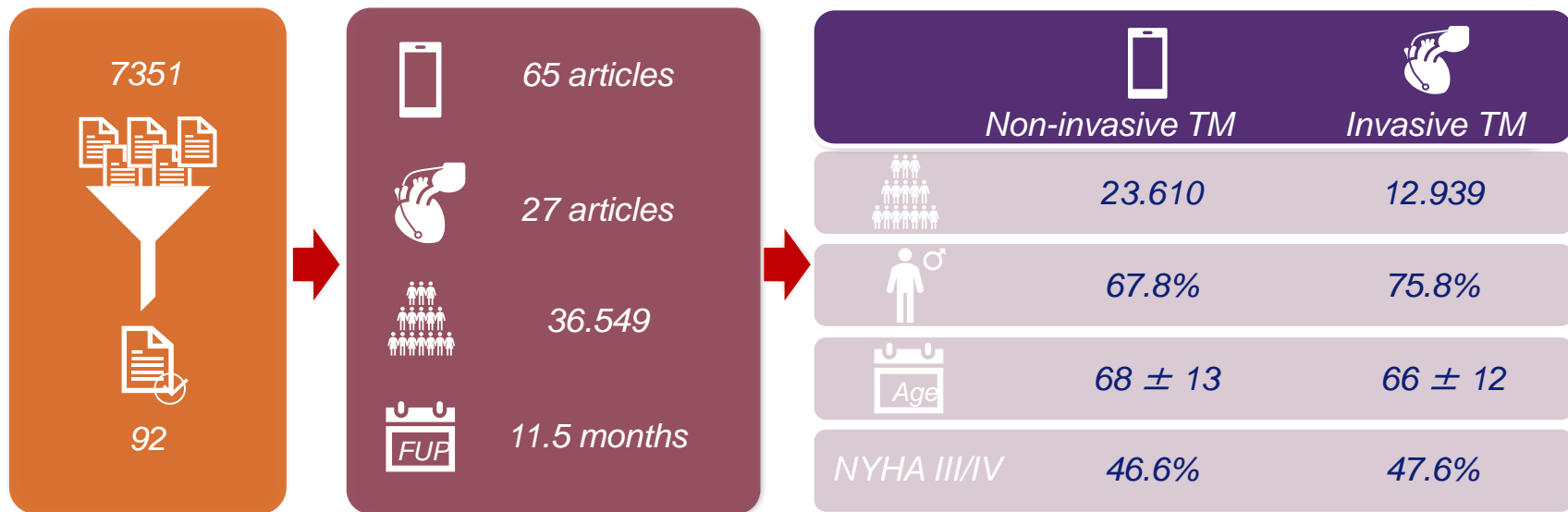


Invasive Hemodynamic Monitoring

Modality in which invasive hemodynamic parameters are used, e.g. (pressure) sensors.

HF = Heart failure, TM = telemonitoring, STS = structural telephone support, PM = pacemaker, ICD = intrinsic cardiac defibrillator.

Meta-analysis telemonitoring for HF patients (n=36.549)



FUP = follow-up, TM = home telemonitoring system, NYHA = New York Heart Association class

Meta-analysis telemonitoring for HF patients

All-cause mortality	No. studies	Intervention	Standard care		Odds ratio [95% CI]	I ²
Non-invasive	56	1337/11472	1365/9985		0.85 [0.77, 0.94]	9%
Telemonitoring	31	656/4998	644/4454		0.91 [0.79, 1.05]	7%
Structured telephone support	18	375/4033	421/3421		0.75 [0.63, 0.89]	9%
Complex telemonitoring	9	306/2441	329/2355		0.88 [0.74, 1.05]	0%
Invasive	24	762/7239	584/5246		0.86 [0.70, 1.06]	50%
Cardiac implantable devices	17	429/4732	472/4323		0.84 [0.65, 1.08]	56%
Invasive hemodynamic monitoring	7	333/2507	112/923		0.96 [0.72, 1.27]	0%
Total	80	2099/18711	1949/15231		0.84 [0.77, 0.93]	24%

Meta-analysis telemonitoring for HF patients

First heart failure hospitalization					Odds ratio [95% CI]	
Non-invasive	39	1639/7468	1766/6651		0.78 [0.70, 0.86]	26%
Telemonitoring	22	1008/3826	1091/3527		0.78 [0.67, 0.92]	39%
Structured telephone support	15	485/2947	599/2788		0.75 [0.65, 0.86]	0%
Complex telemonitoring	4	146/695	128/545		0.79 [0.50, 1.23]	48%
Invasive	15	562/2884	497/2268		0.89 [0.77, 1.03]	5%
Cardiac implantable devices	11	417/2410	440/2128		0.92 [0.79, 1.06]	1%
Invasive hemodynamic monitoring	4	145/474	57/140		0.68 [0.42, 1.09]	0%
Total	54	2201/10352	2263/8883		0.81 [0.74, 0.88]	22%

Meta-analysis telemonitoring for HF patients

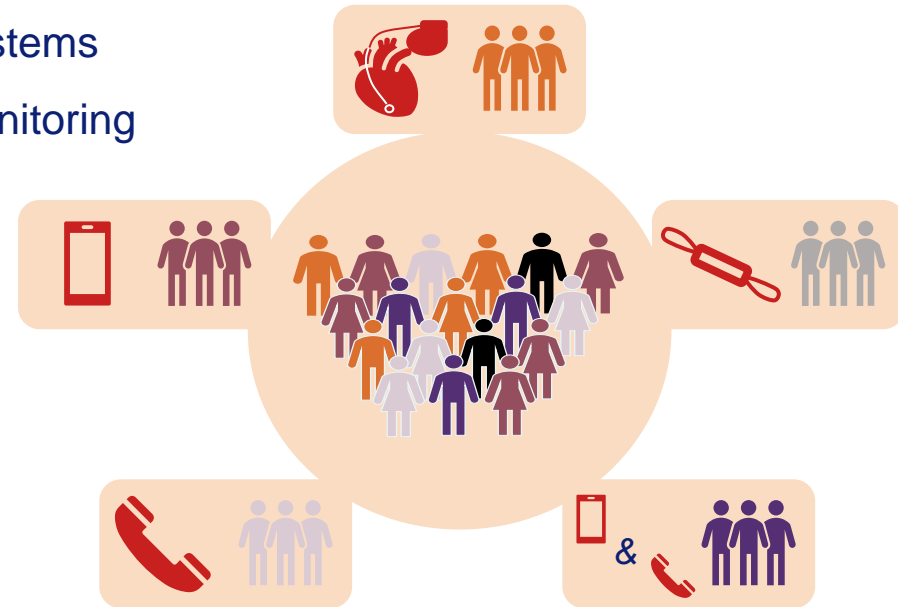
Total/recurrent heart failure hospitalization	No. events per person year	Incidence risk ratio [95% CI]	
Non-invasive	21	0.363	0.389
Telemonitoring	13	0.446	0.472
Structured telephone support	5	0.327	0.378
Complex telemonitoring	4	0.140	0.141
Invasive	13	0.385	0.296
Cardiac implantable devices	7	0.195	0.199
Invasive hemodynamic monitoring	6	0.605	0.584
Total	34	0.373	0.350

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Meta-analysis telemonitoring for heart failure patients

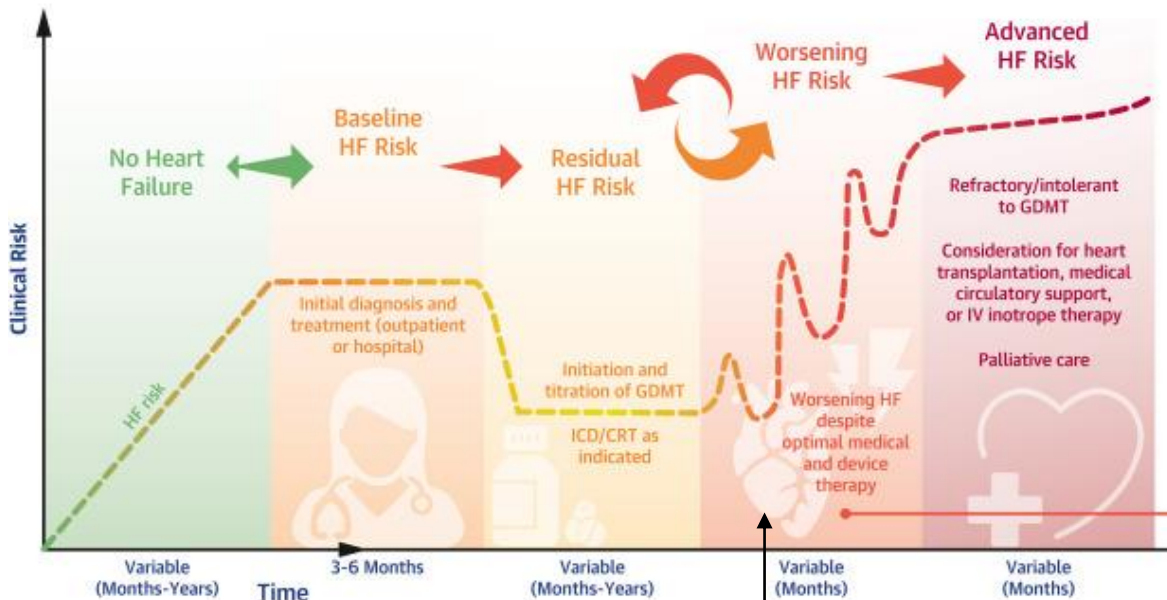
1. An **advocacy** for the use of telemonitoring systems
 - for both non-invasive and invasive telemonitoring
2. The methods of TM are **heterogeneous**
3. Future research:
 - **Personalizing** telemonitoring systems



Key question:

- which system is most suitable for which patient?

Wanneer in het ziekte proces maak je de meeste impact met monitoring?

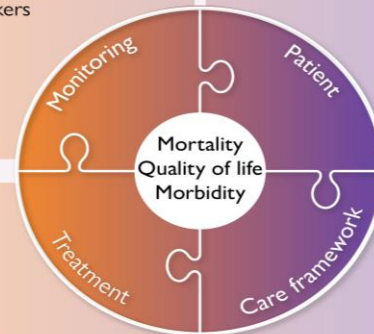


Greene et al JACC 2023, Angerman et al EHJ 2023

Cycle of remote patient management and key elements that shape personalized care strategies for heart failure patients

- Haemodynamic (invasive)
- Multiparametric (CIED or non invasive)
- Novel digital technologies (wearables, apps...)
- Clinical (self) monitoring
- Biomarkers

- Individual risk profile
- Patient preference
- Motivation and compliance
- Cognitive function
- Digital and health literacy
- Social circumstances

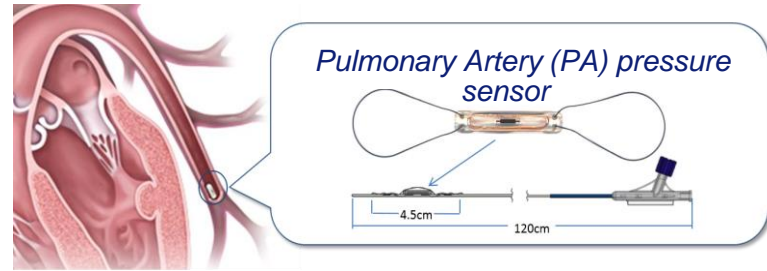


- Patient activation and empowerment
- Shared decisions (monitoring and treatment)
- Diuretics and GRMT
- Comorbidities
- Palliative needs

- Multidisciplinary team
- Processing of monitoring results (use of AI)
- Structured workflows
- Reimbursement
- Country-specific healthcare systems

MONITOR-HF

- 3rd RCT, 1st EU, multicentre, n=348
- Chronic HF, NYHA III and 1 HFH
- 1:1 randomised to:
 - standard of care vs. PA-guided therapy
 - identical follow-up scheme
- Outcomes:
 - primary endpoint: KCCQ-OS at 12 months
 - secondary endpoint: total HF-hospitalisations
- Mean follow-up 1.8 yrs (up to 48 months)



Patient electronics system



PA pressure database



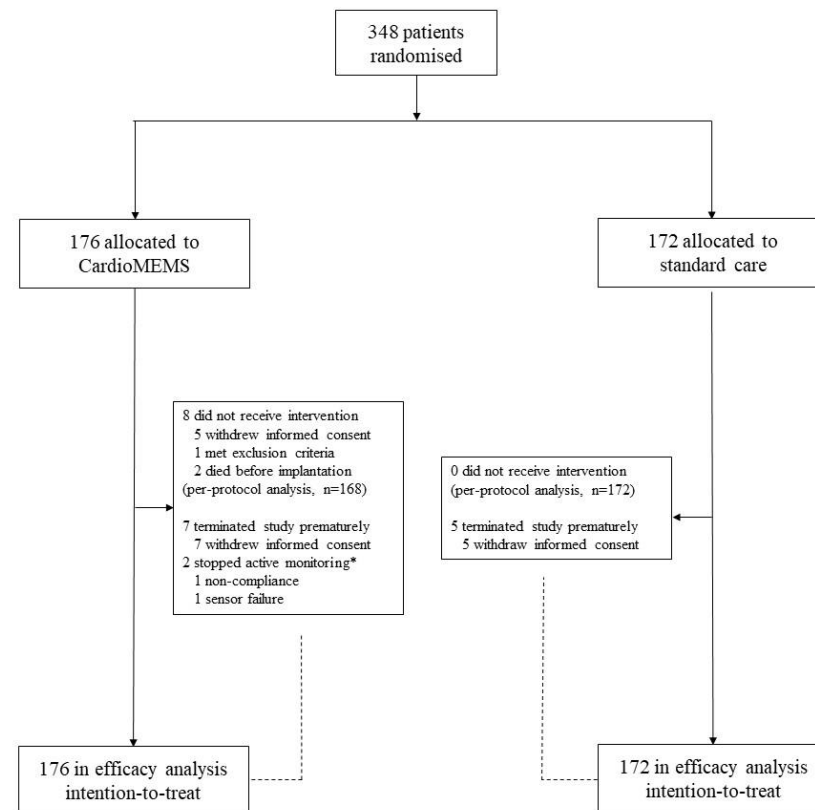
Physicians access secure website

Baseline characteristics and trial flow scheme

	CardioMEMS (N=176)	Standard Care (N=172)
Age*	69 (61-75)	70 (61-75)
Male sex (%)	138 (78.4%)	125 (72.7%)
Diabetes, %	66 (37.5%)	68 (39.5%)
Atrial fibrillation, %	100 (56.8%)	81 (47.1%)
Etiology, ischemic, %	93 (52.8%)	81 (47.1%)
LVEF, median (IQ)	30 (23-40)	30 (22-43)
- EF <40%	72.7%	71.5%
- EF ≥40%	27.3%	28.5%
eGFR (ml/min)*	48 (35-60)	48 (38-63)
NT-proBNP (pg/ml)*	2377 (837-5153)	1905 (691-4444)
ICD, %	94 (53.4%)	102 (59.3%)
CRT, %	46 (26.1%)	46 (26.7%)
Medical therapy		
Beta-blocker, %	150 (85.2%)	142 (82.6%)
RAASi, %**	154 (87.5%)	147 (85.5%)
MRA, %	143 (81.3%)	144 (83.7%)
SGLT2 inhibitor, %	12 (6.8%)	21 (12.2%)
Loop diuretic, %	168 (95.5%)	167 (97.1%)

No significant differences between groups

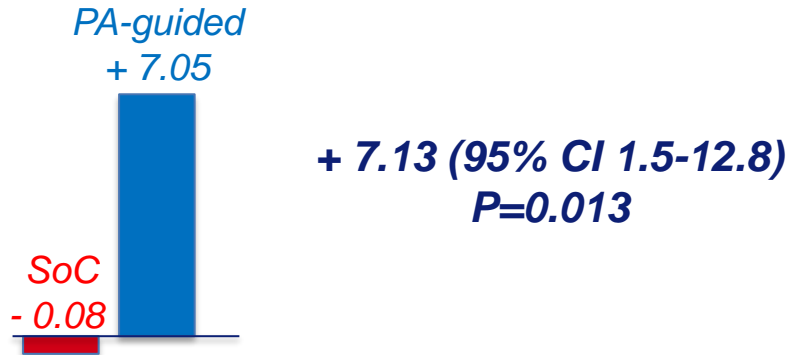
* Median (IQ range) ** ARNI 46.0 and 47.1% at baseline



Quality of life (KCCQ-OS)

Mean KCCQ-OS (SD)	PA-guided	SoC	P-value
- Baseline (n=348)	55.8 (23)	54.9 (22)	0.69
- 12 months (n=279)	66.1 (25)	56.9 (24)	0.01

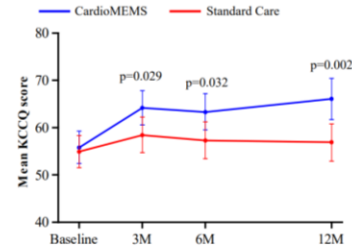
Mean difference baseline to 12M (group level)



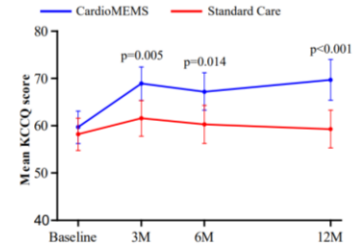
Sensitivity analyses for missing data yielded similar results

KCCQ-OS = Kansas City Cardiomyopathy Questionnaire Overall Summary Score

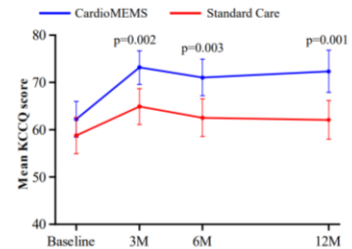
A KCCQ Overall Summary Score



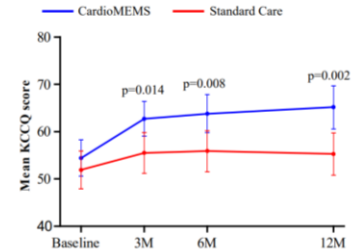
B KCCQ Clinical Summary Score



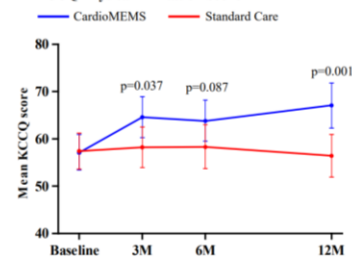
C KCCQ Total Symptom Score



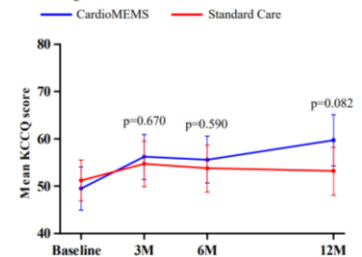
D KCCQ Quality of Life Score



E KCCQ Physical Limitation Score



F KCCQ Social Limitation Score

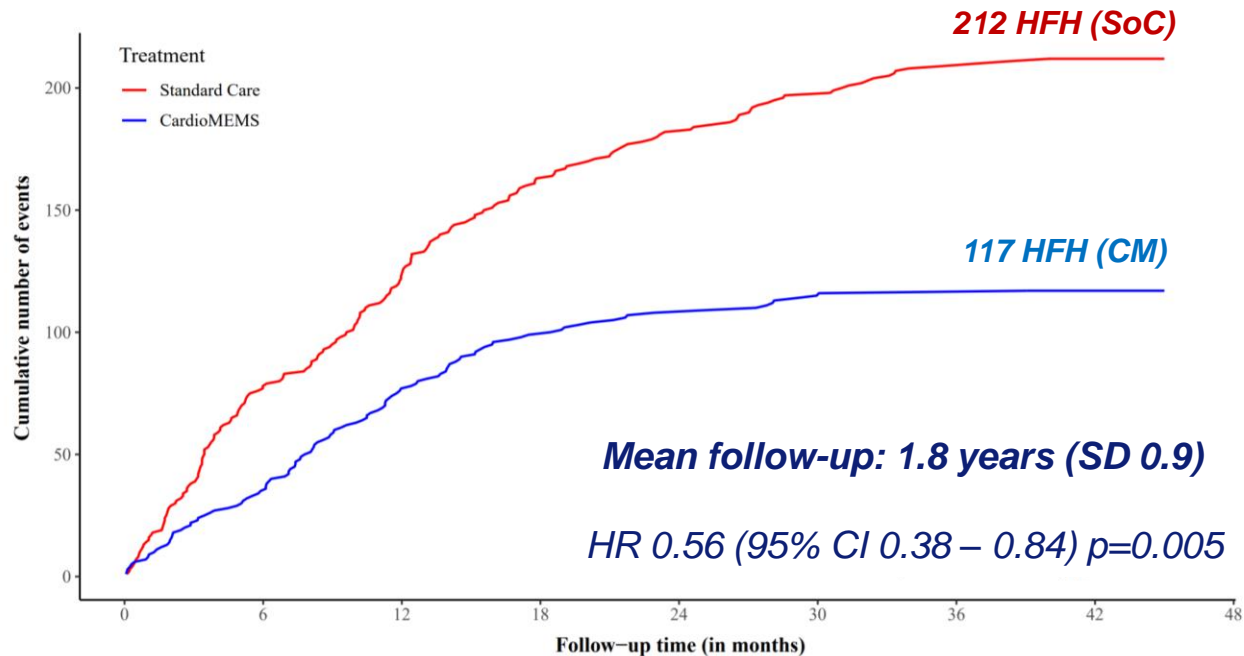


Reduction in number of total HF hospitalisations

Cox-regression analysis

Andersen-Gill method

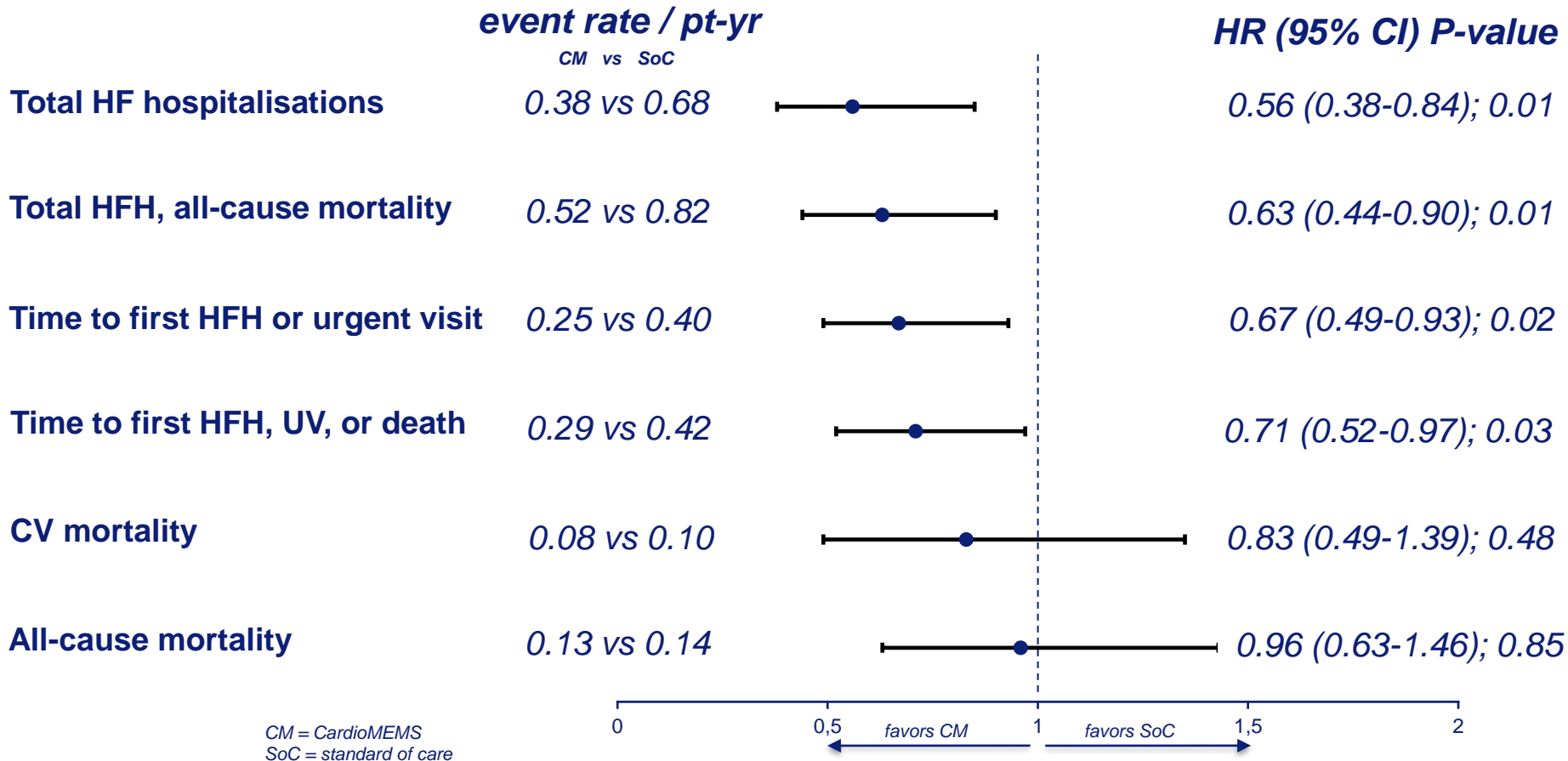
(recurrent events)



Number at risk

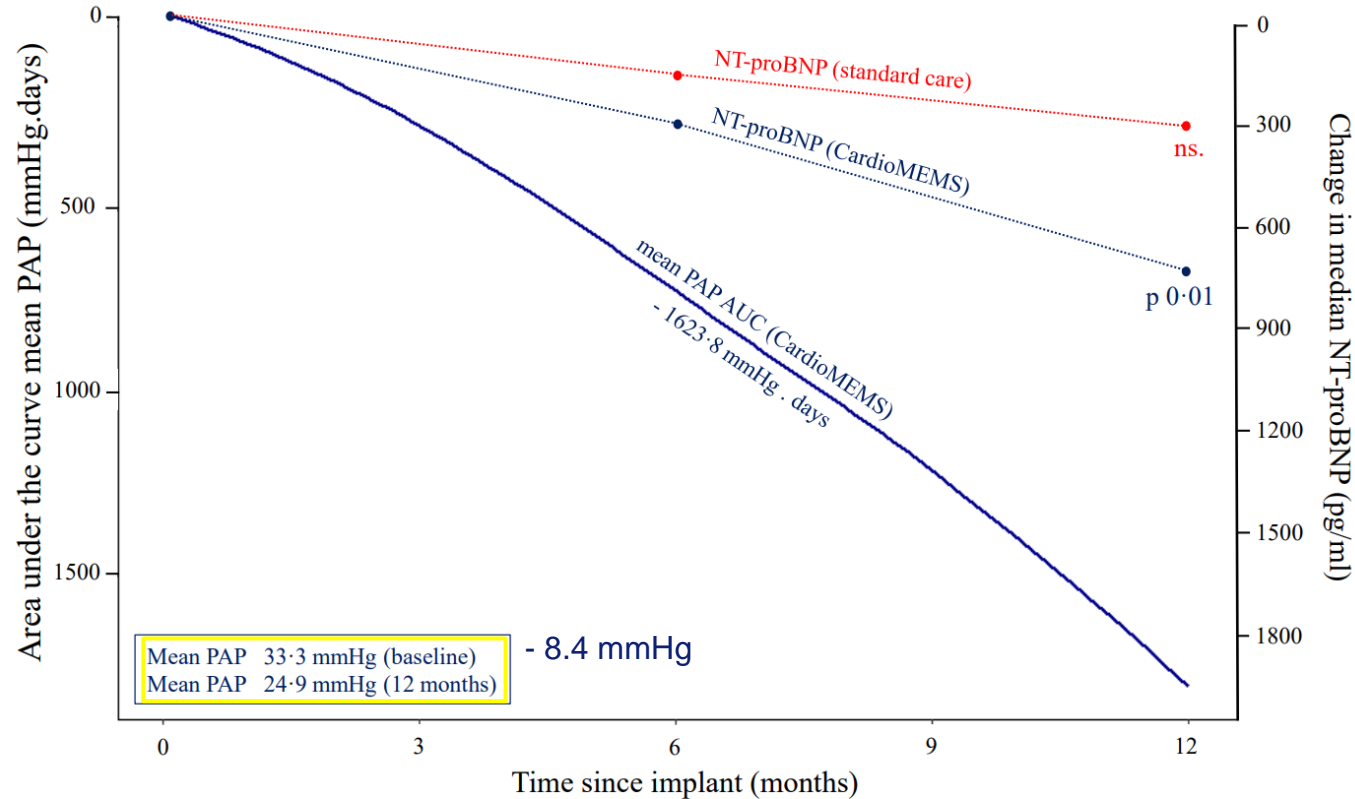
CardioMEMS	176	159	130	93	66	41	20	7	0
Standard Care	172	160	147	102	67	40	22	2	0

Clinical Endpoints



Effect of the Intervention at Multiple Levels

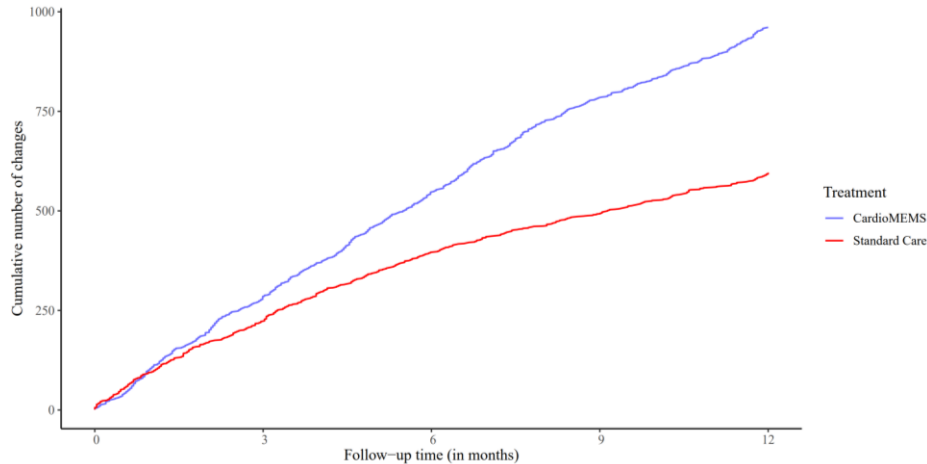
- Strong reduction in mean PA pressure by -8.4 mmHg
- Significant reduction in NT-proBNP, only in PA-guided group



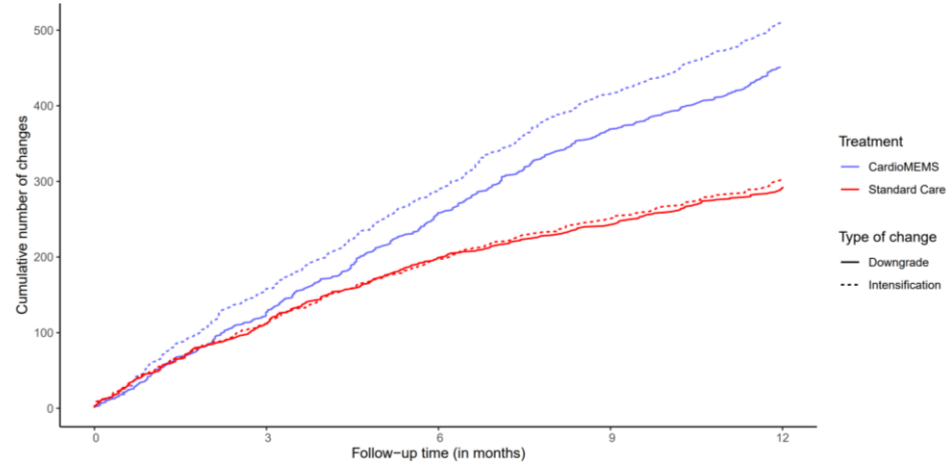
Mode of effect: primarily by changes in diuretics

- Remote optimization of diuretics based upon PA pressures as surrogate of LV filling pressures
- Monitor hypervolemia and hypovolemia in a controlled way
 - down- and up-titrations (works both ways)
- **Chronically better decongestive state**

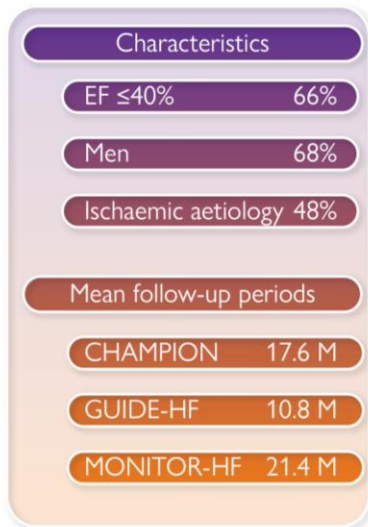
A. Cumulative changes in diuretics



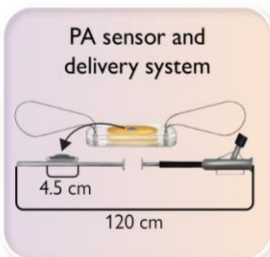
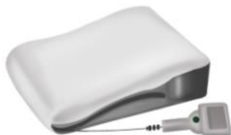
B. Type of changes in diuretics: fine-tuning



Meta-analyse 3 RCTs PAP guided therapy (n=1.898)



Patient electronic system

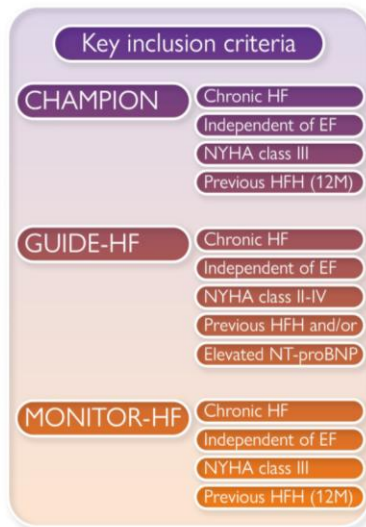


PA sensor and delivery system

PA pressure database



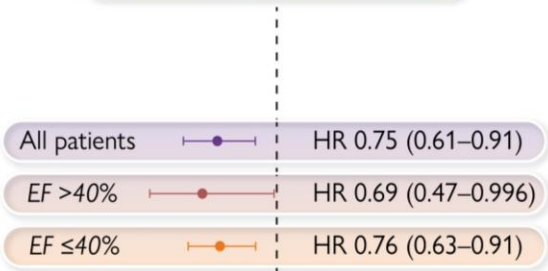
Physician access via secure website



Clinical endpoints



Total HFH, urgent visits and death



4 additional studies with PA-sensors

	MEMS-HF (n=234) 2020	PAS-study (n=1200) 2020	COAST (N=100) 2023	SIRONA-2 (n=70) 2023
Patients	NYHA III, 1 previous HFH	NYHA III, 1 previous HFH	NYHA III, 1 previous HFH	NYHA III, 1 HFH or nt-proBNP
Reduction in HFH	- 62% (52-69%); P<0.001	- 57% (53-61%); P<0.001	- 82% (72-88%) P<0.001	-73% P<0.001
Events/pt-yr	1.55 vs 0.60	1.25 vs. 0.54	1.52 vs. 0.27	n.a.
Freedom of complications	98,3%	99,6%	100%	98,7%
Freedom of sensor fail.	99,6%	99,9%	99%	100%

HFH = HF hospitalisations

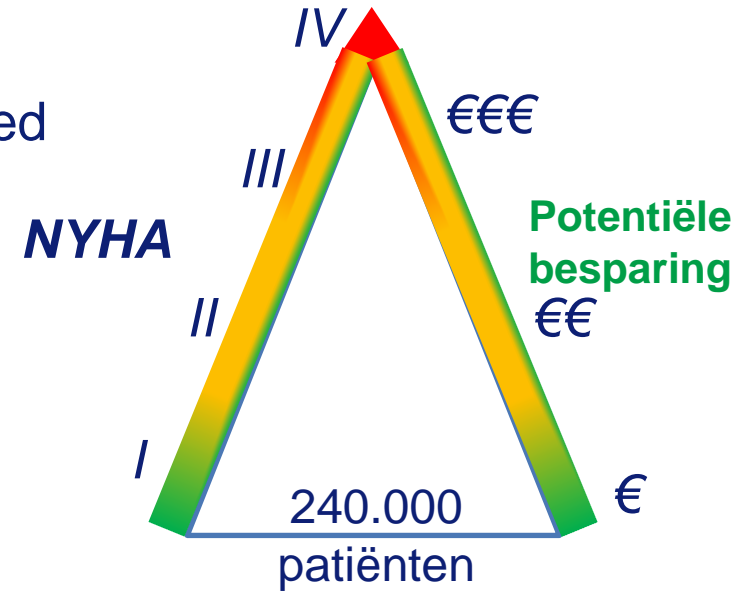
Angermann et al EJHF 2020; Shavelle et al Circ HF 2020;
Cowie et al. ESC HF 2023; Aßmus et al ESC HFA 2023

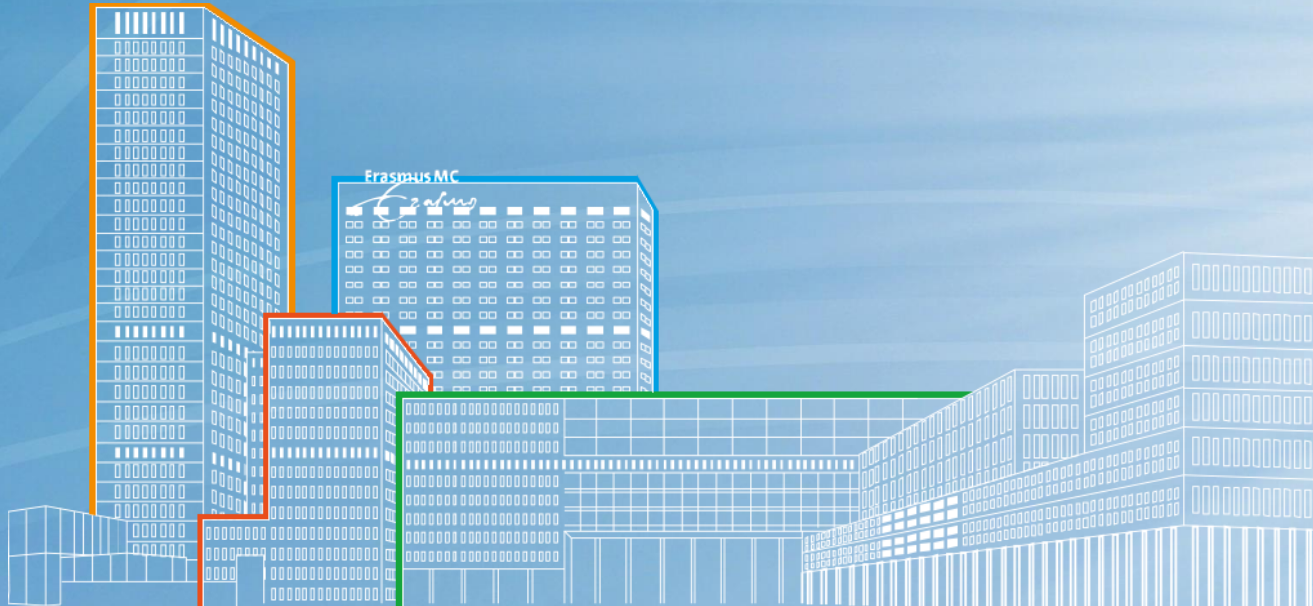
Volgende stappen PA-sensoren (NL)

- Eenvoudige en klinisch intuïtieve parameter om te volgen
- Gereserveerd voor een zieke populatie met matig-ernstig HF
 - schaalgrootte 250 pt/jr, geen oplossing voor allen
- Toekomst:
 - 1) evolutie van het product 2) meerdere PA sensors (Cordella)
 - Algoritmen, AI, automatisering, integratie EPD,
 - App met druk feedback → patiënt closed loop: self-care/management
- Vervolg:
 - BioMEMS: seriële biomarkers in MONITOR-HF op 0,3,6,12 M
 - Subgroep analyses PHT, nierfunctie en echo parameters tijdens fup

Toekomst van telemonitoring

- Waar willen we naar toe?
 - Structuur, standardisatie, evidence-based
 - Minder heterogeen
- Determinanten van telemonitoring:
 - Patienten selectie vs. volume
 - Kosten vs. volume
 - Welke techniek voor wie het meeste effect





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