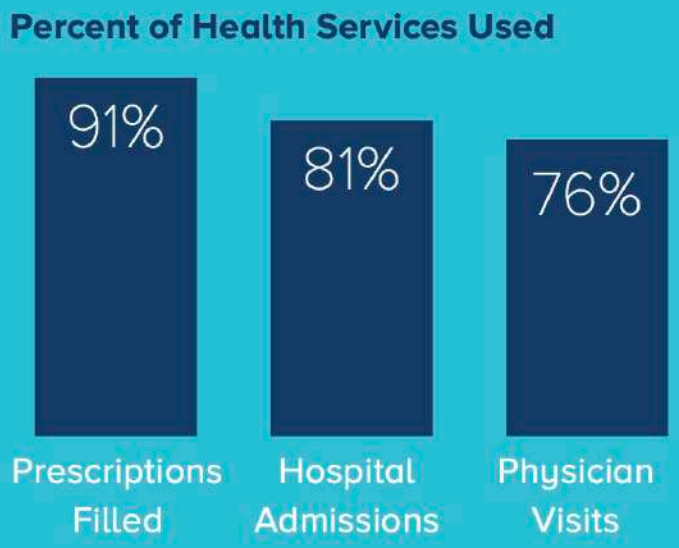
Remote Patient Monitoring. Can digital medicine create a revolution in Heart Failure Management?

Ulvi Mirzoyev, MD, PhD, FESC

- Value Based Healthcare
- Digital Health
- Episodic vs Continuous care
- Reactive vs Proactive
- Synchronous vs Asynchronous
- Online, Offline, Hybride
- Hospital@Home

PERCENT OF HEALTH RESOURCES USED BY PEOPLE WITH CHRONIC CONDITIONS



People with chronic diseases use the majority of heath care services and account for most of costs.

"With automated monitoring and workflow, patients get exactly what they need when they need it: the majority of patients carry on as usual, while patients who experience a change in symptoms or side effects have access to context-specific, automated recommendations that can react to what they've reported. Healthcare providers only take action on patients who truly need a caregiver's attention."

#1

Hospital admission reason
is Heart Failure

$346 bn

Heart Failure **costs worldwide**

50–75 %

of costs **due to hospitalizations**

Sources: European Society of Cardiology (2023), Diamond et al. (2022), Hessel et al. (2021), Lippi et al. (2020).

“Avoiding Re-hospitalizations is the Holy Grail of Heart Failure“

Within 5 years, over 50% of CHF patients still die

Sources: Huusko, Jenni & Kurki, Samu & Toppila, Iiro & Purmonen, Timo & Lassenius, Mariann & Gullberg, Elisabet & Wirta, Sara & Ukkonen, Heikki. (2019). Heart failure in Finland: clinical characteristics, mortality, and healthcare resource use. ESC Heart Failure. 6. 10.1002/ehf2.12443.

Value Based Healthcare

EXPERIENCE

OUTCOMES

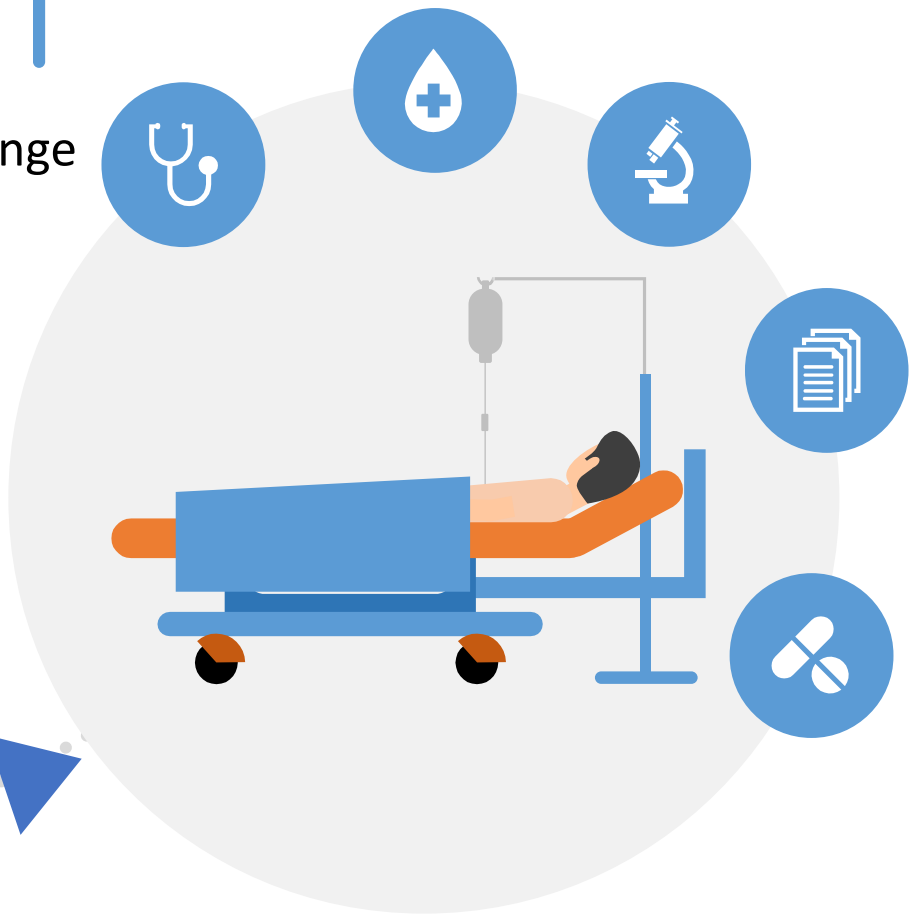
COSTS

Digital Medicine: Catalisator

- Telehealth
- RPM
- Mhealth programs
- EHRs
- Health Information Exchange
- Data Analytics and AI

Benefits of Digital Mediicine:

- Enhanced access to care in underserved and rural areas
- Improved care coordination and communication between caregivers
- Prompt information availability for better decision-making
- Individualised treatment based on patient-driven data
- Patients empowerment



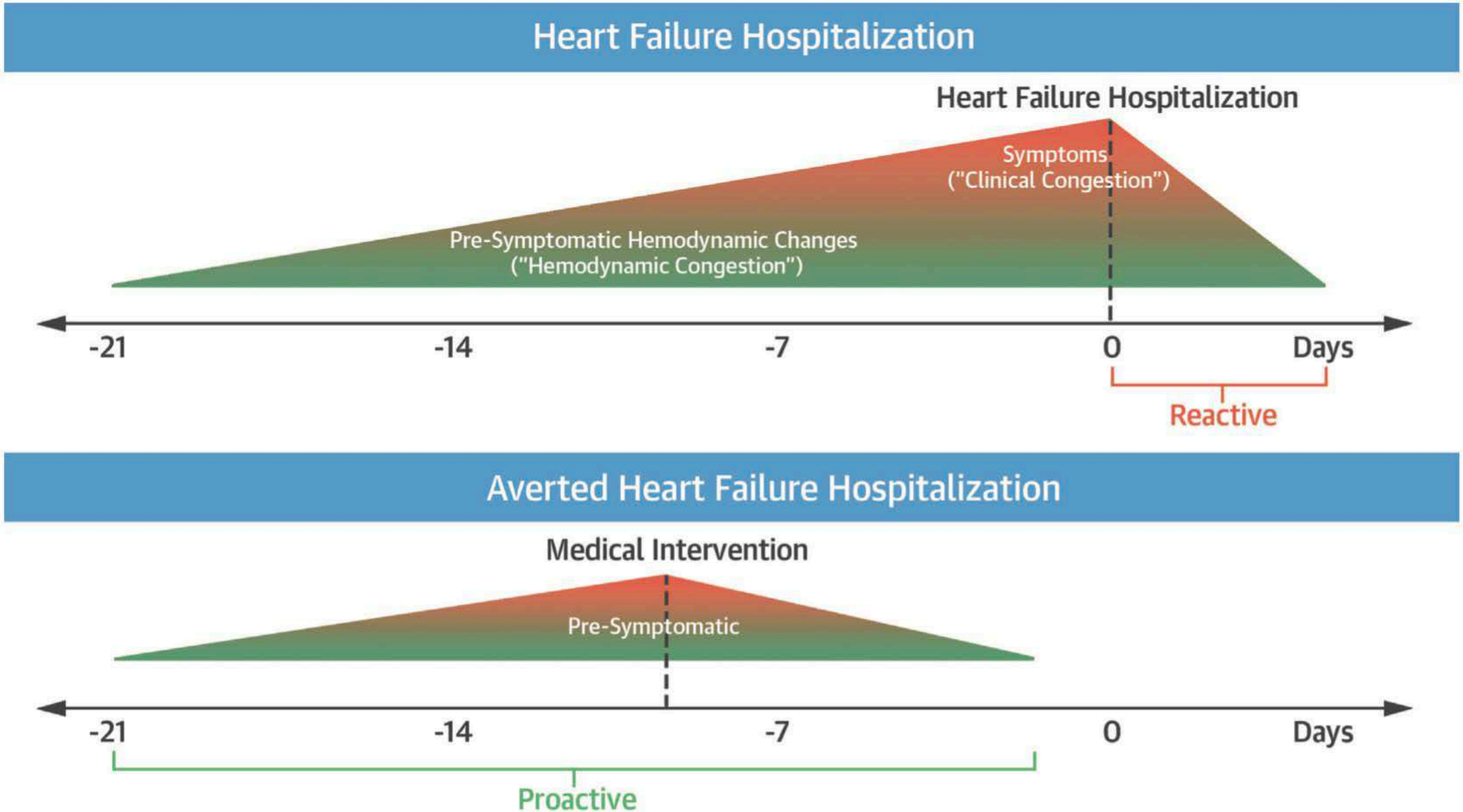
Remote Patient Management (RPM)

Definition:

- Remote patient management (RPM) involves the use of technology to monitor and manage patients' health conditions remotely, often from their own homes.

Main Advantages:

- **Proactive approach**: enables continuous monitoring of vital signs and symptoms, early intervention and reduces hospital readmissions.
- **Increased patient participation**: Patients become active participants in their treatment, increasing adherence
- **Cost savings**: RPM can reduce healthcare costs by preventing complications and hospitalizations.



Abraham, W.T. et al. J Am Coll Cardiol. 2017;70(3):389-98.

Weights and Vital Signs

Symptoms

Lung Congestion

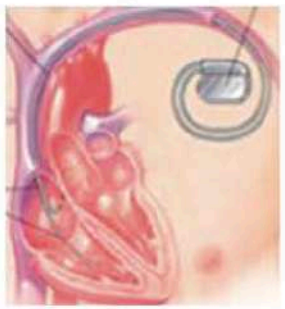
Dielectric Sensing through vest

Radiofrequency through adhesive patch

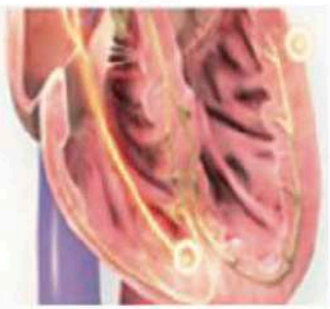
Thoracic Impedance through device lead

Multi-parameter scoring of risk through implanted rhythm devices

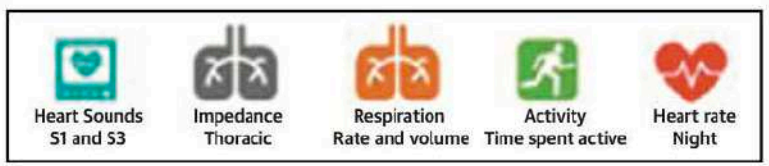
ICD



CRT



Proprietary algorithms with different components

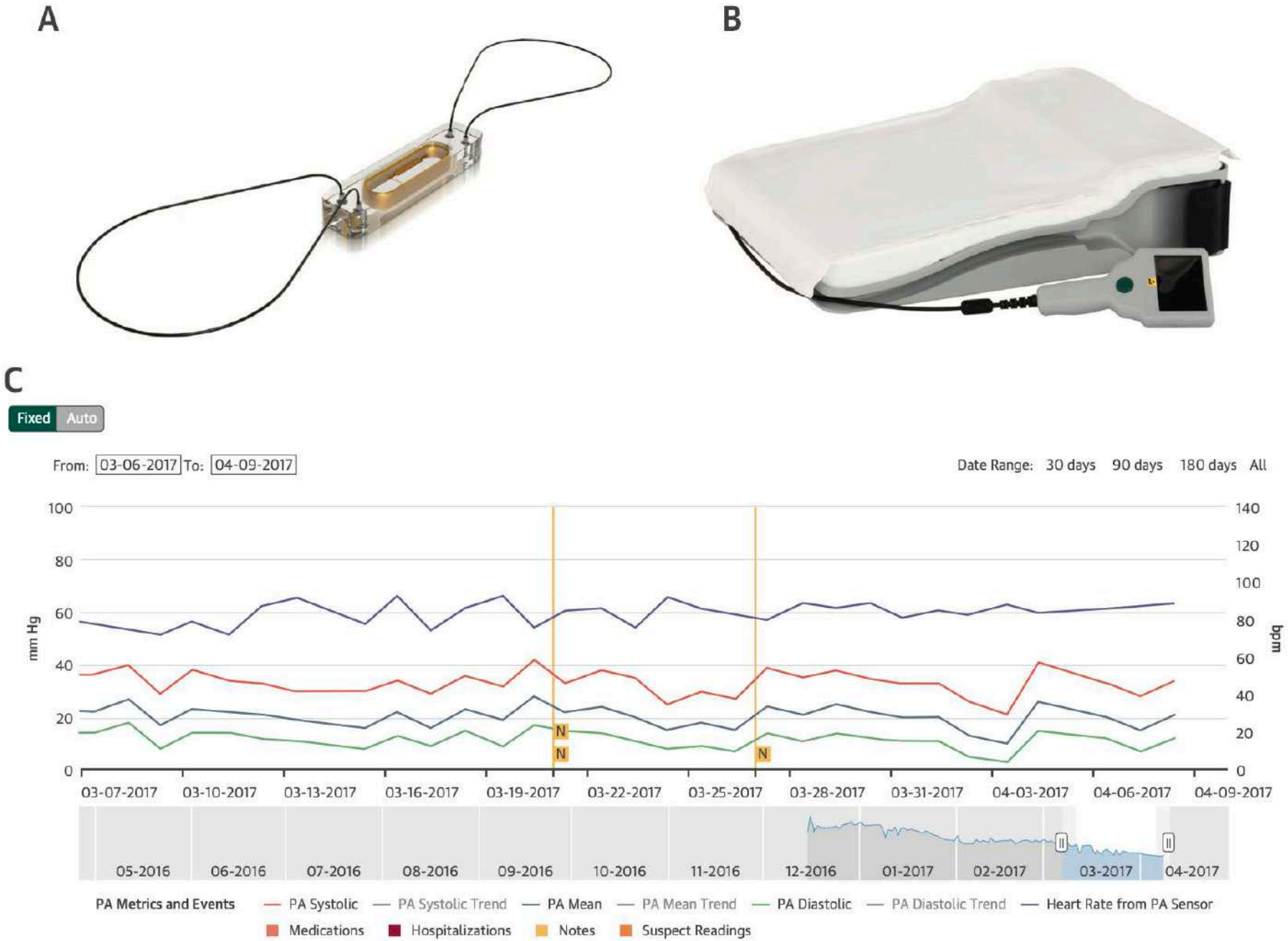


Direct measurement of cardiac pressures

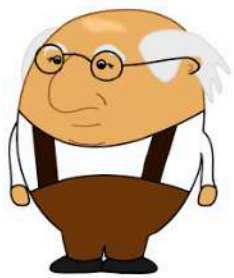
Pulmonary artery pressures

Left atrial pressures

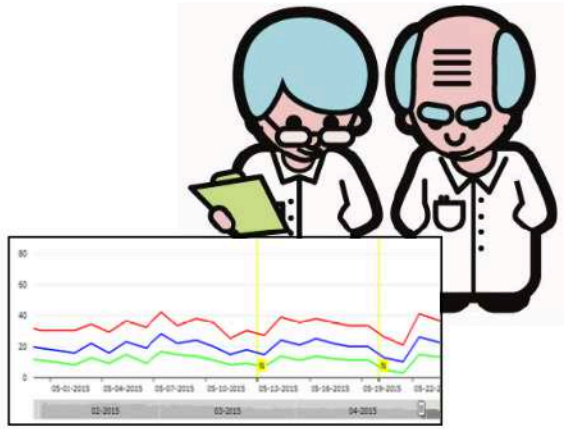
FIGURE 1 The Major Components of the CardioMEMS HF System



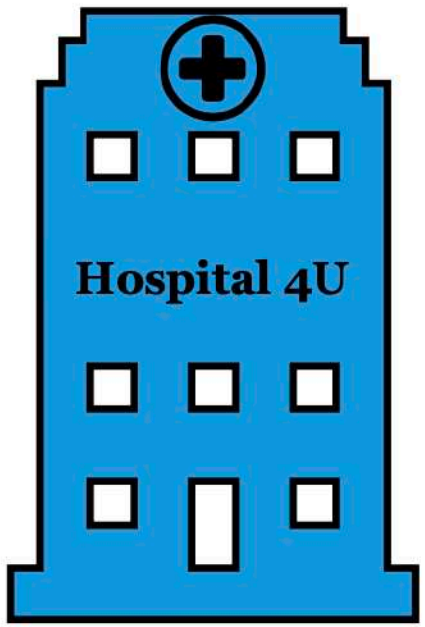
CardioMEMS HF System



Daily Pulmonary Artery Pressure Readings



Proactive Therapy Updates

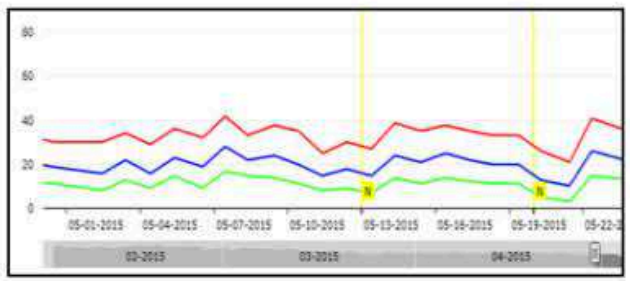


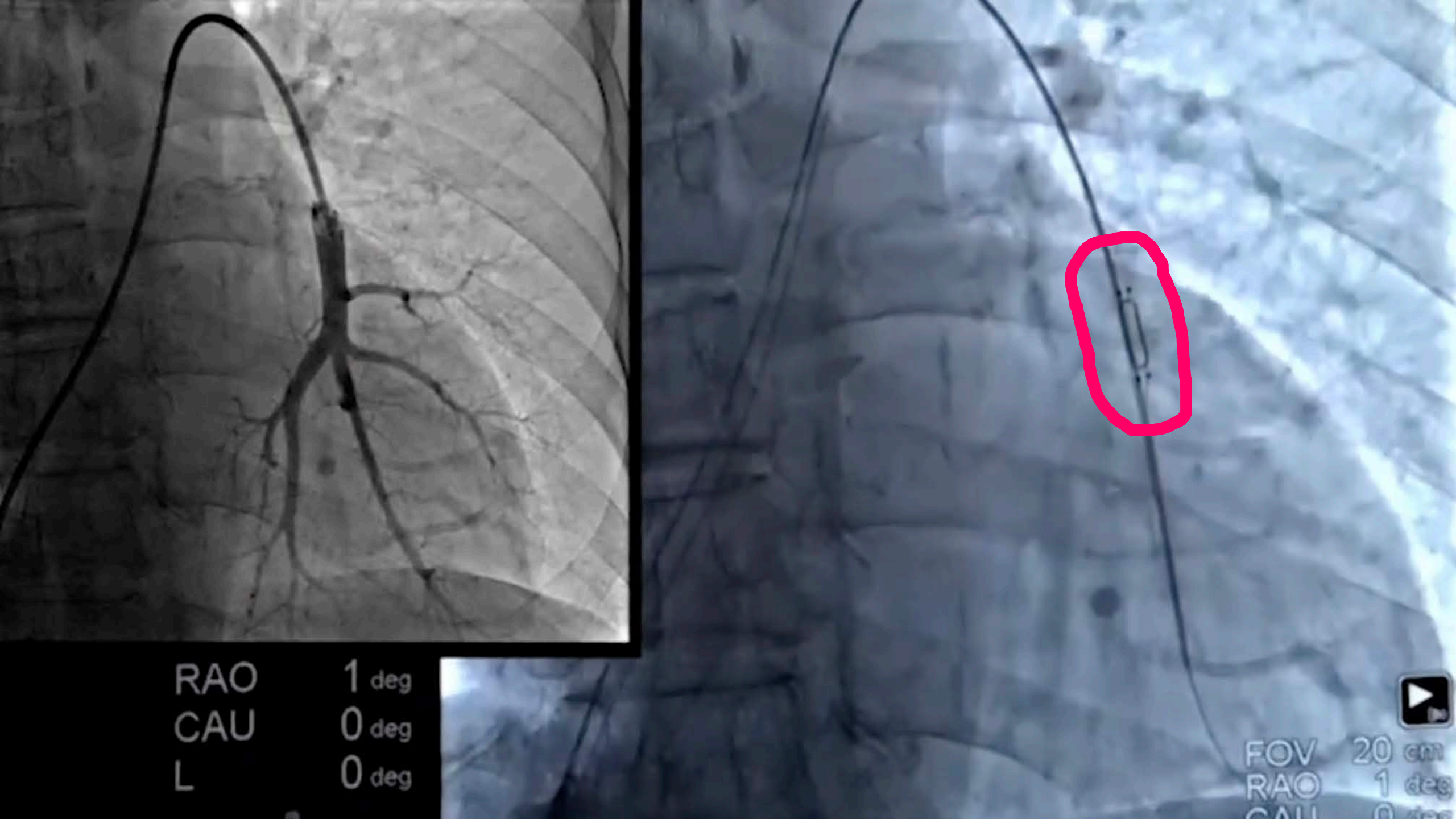
Heart Failure Patient

- NYHA III
- At least 1 HF hospitalization in the year prior to implant/inclusion
- BMI < 35

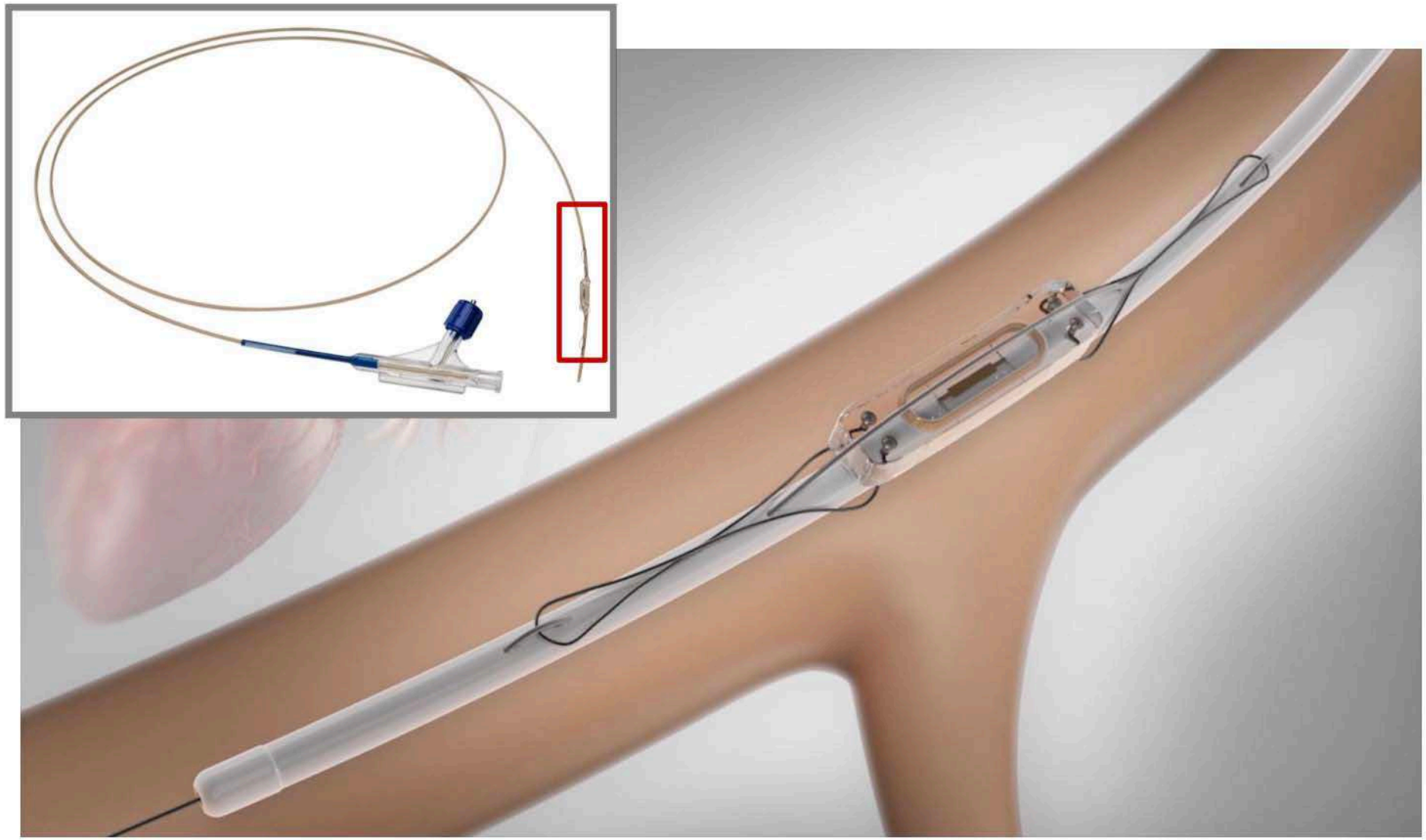
CardioMEMS HF System

Pulmonary Artery Pressure Sensor + Patient Electronics System + CardioMEMS Website Merlin.net

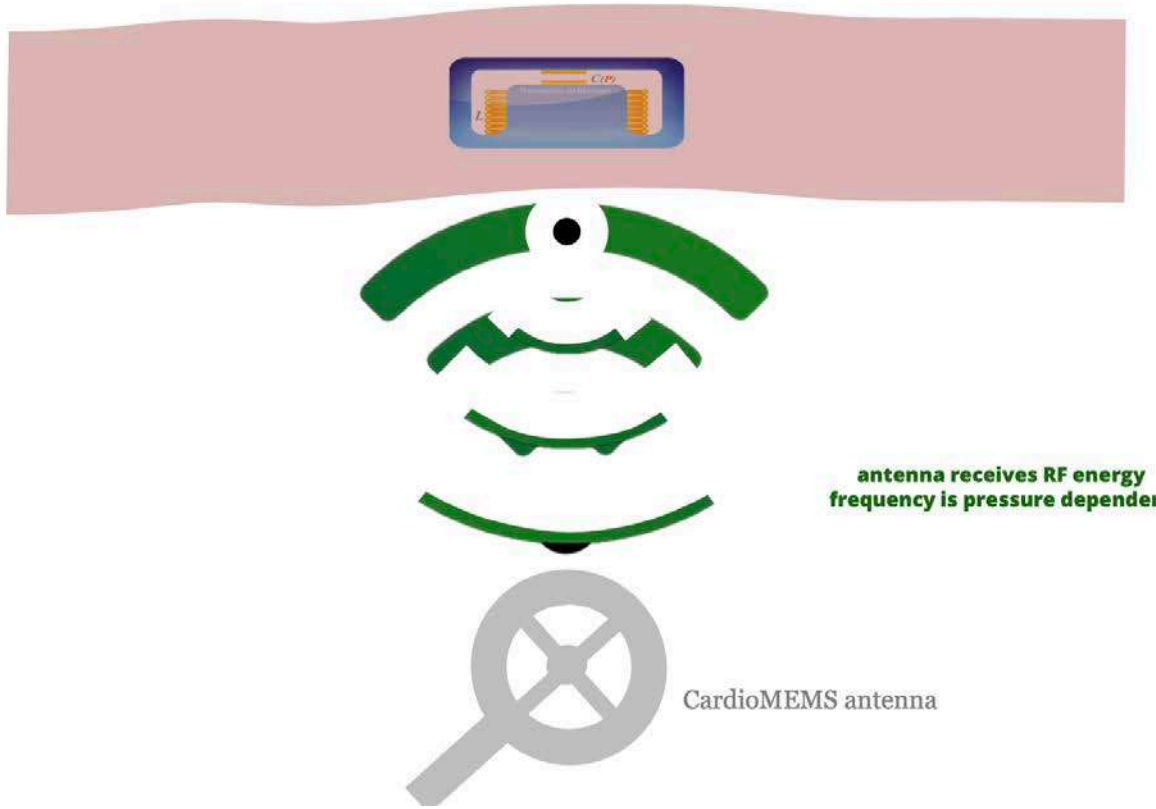



RAO 1 deg
CAU 0 deg
L 0 deg
FOV 20 cm
RAO 1 deg

Sensor Release



Taking a PAP Reading



antenna receives RF energy
frequency is pressure dependent

CardioMEMS antenna

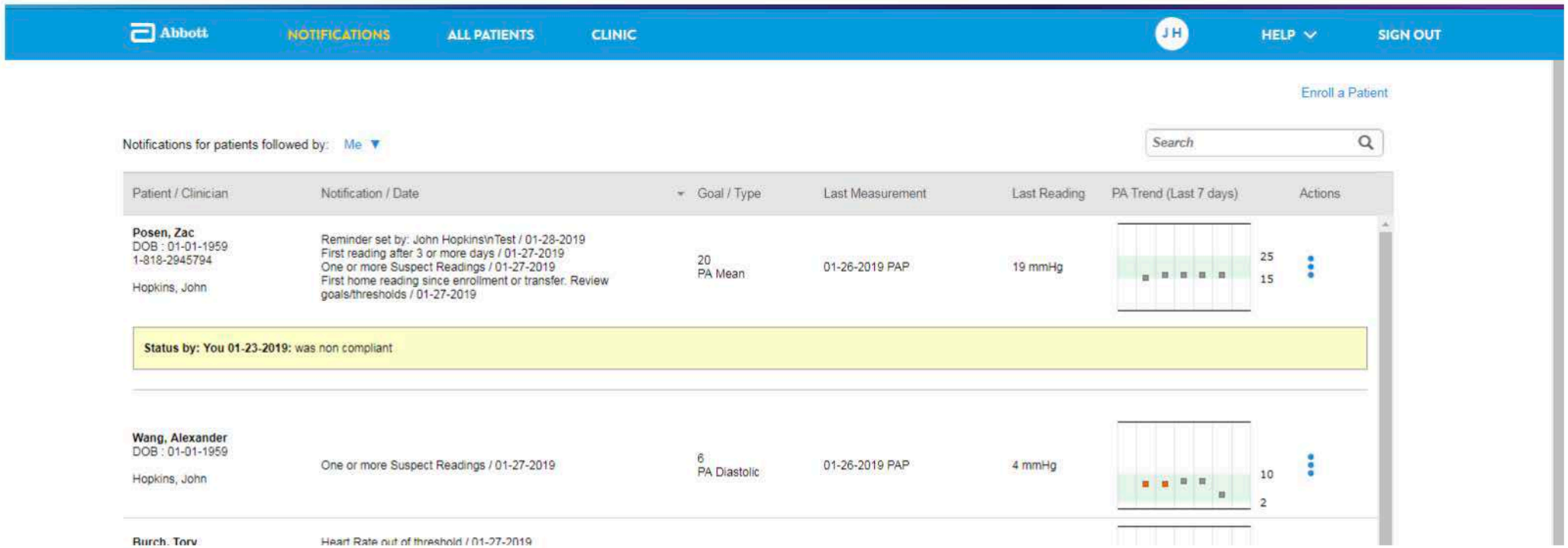
Patient Electronics Unit

Patient Electronics Unit

- **Handheld display shows relevant information e.g.**

- **The Patient Electronics Unit provides spoken instructions in local language**
- **After the implant the patient is trained how to use of the PEU at home**

The Notifications List: Only The Patients Who Need My Attention



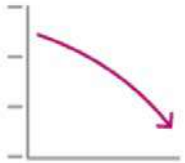
57%
HFH reduction regardless of EF

Reduction in PA Pressures

2020

US Post-Approval Study

Shavelle et al.



$13K
reduction in cost

2017

Real-World Economic Impact

Desai et al.

62%
HFH reduction

Improved Quality of Life

2020

MEMS-HF Europea Study

Angermann et al.

43%
HFH reduction with CardioMEMS & optimal GDMT

2017

act with Guideline-Directed Medical Therapy

Givertz et al.

24%
HFH reduction

30%
Mortality Reduction

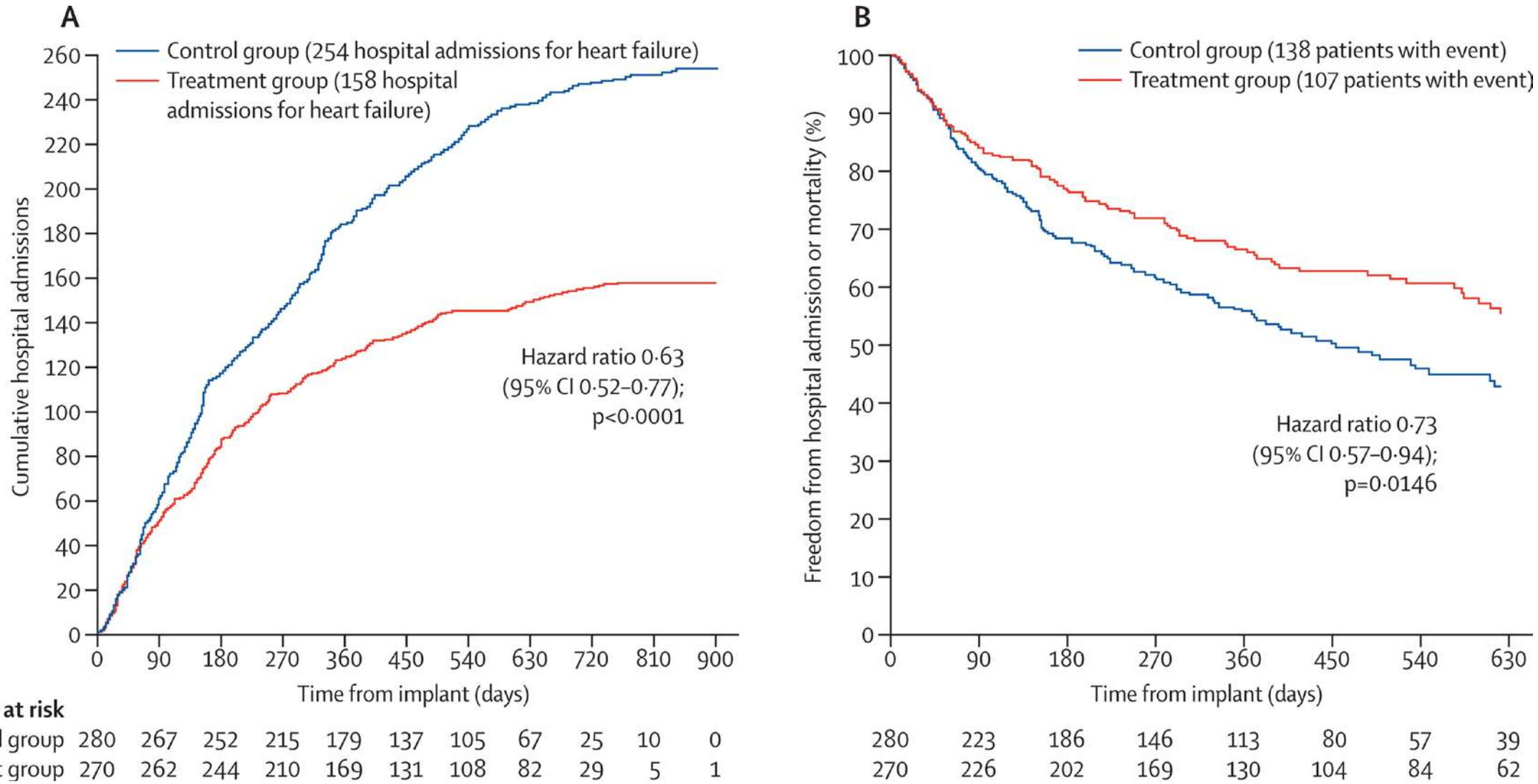
2019

Propensity-Matched Cohort Outcomes

Abraham et al.

CardioMEMS HF System

CHAMPION


A
Control group (254 hospital admissions for heart failure)
Treatment group (158 hospital admissions for heart failure)
Cumulative hospital admissions
Hazard ratio 0·63
(95% CI 0·52–0·77);
p<0·0001
Time from implant (days)
Number at risk
Control group 280 267 252 215 179 137 105 67 25 10 0
Treatment group 270 262 244 210 169 131 108 82 29 5 1
B
Control group (138 patients with event)
Treatment group (107 patients with event)
Freedom from hospital admission or mortality (%)
Hazard ratio 0·73
(95% CI 0·57–0·94);
p=0·0146
Time from implant (days)
280 223 186 146 113 80 57 39
270 226 202 169 130 104 84 62

Remote haemodynamic monitoring of pulmonary artery pressures in patients with chronic heart failure (MONITOR-HF): a randomised clinical trial

Jasper J Brugts, Sumant P Radhoe*, Pascal R D Clephas†, Dilan Aydin†, Marco W F van Gent, Mariusz K Szymanski, Michiel Rienstra, Mieke H van den Heuvel, Carlos A da Fonseca, Gerard C M Linssen, C Jan Willem Borleffs, Eric Boersma, Folkert W Asselbergs, Arend Mosterd, Hans-Peter Brunner-La Rocca, Rudolf A de Boer for the MONITOR-HF investigators*

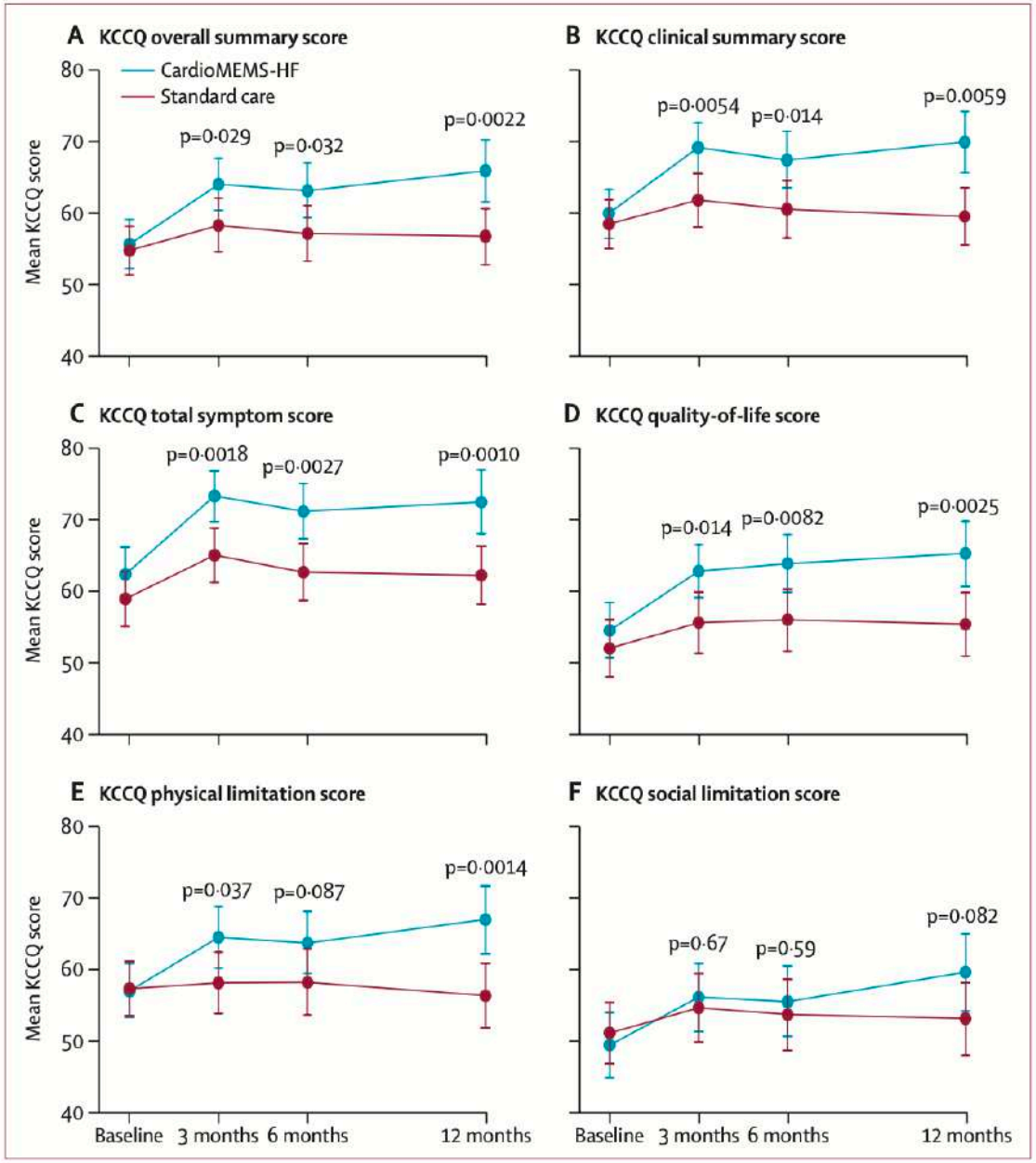


Figure 2: **Mean KCCQ score domains during follow-up**
p values are presented at each timepoint for the difference between groups. The KCCQ contains six domains with plotted mean values of both treatment groups. KCCQ=Kansas City Cardiomyopathy Questionnaire.

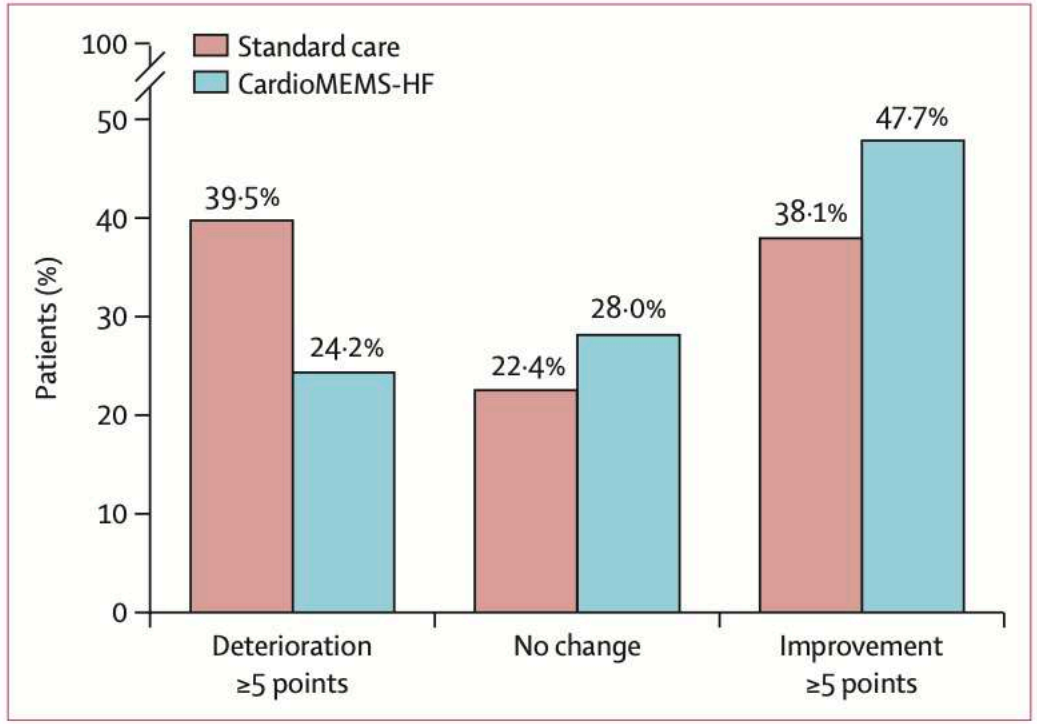


Figure 3: **Proportions of patients with improvement or deterioration in quality of life as measured by the change in KCCQ overall summary score at 12 months**
χ^2 p=0·022 for the difference between groups in the three quality-of-life change categories.

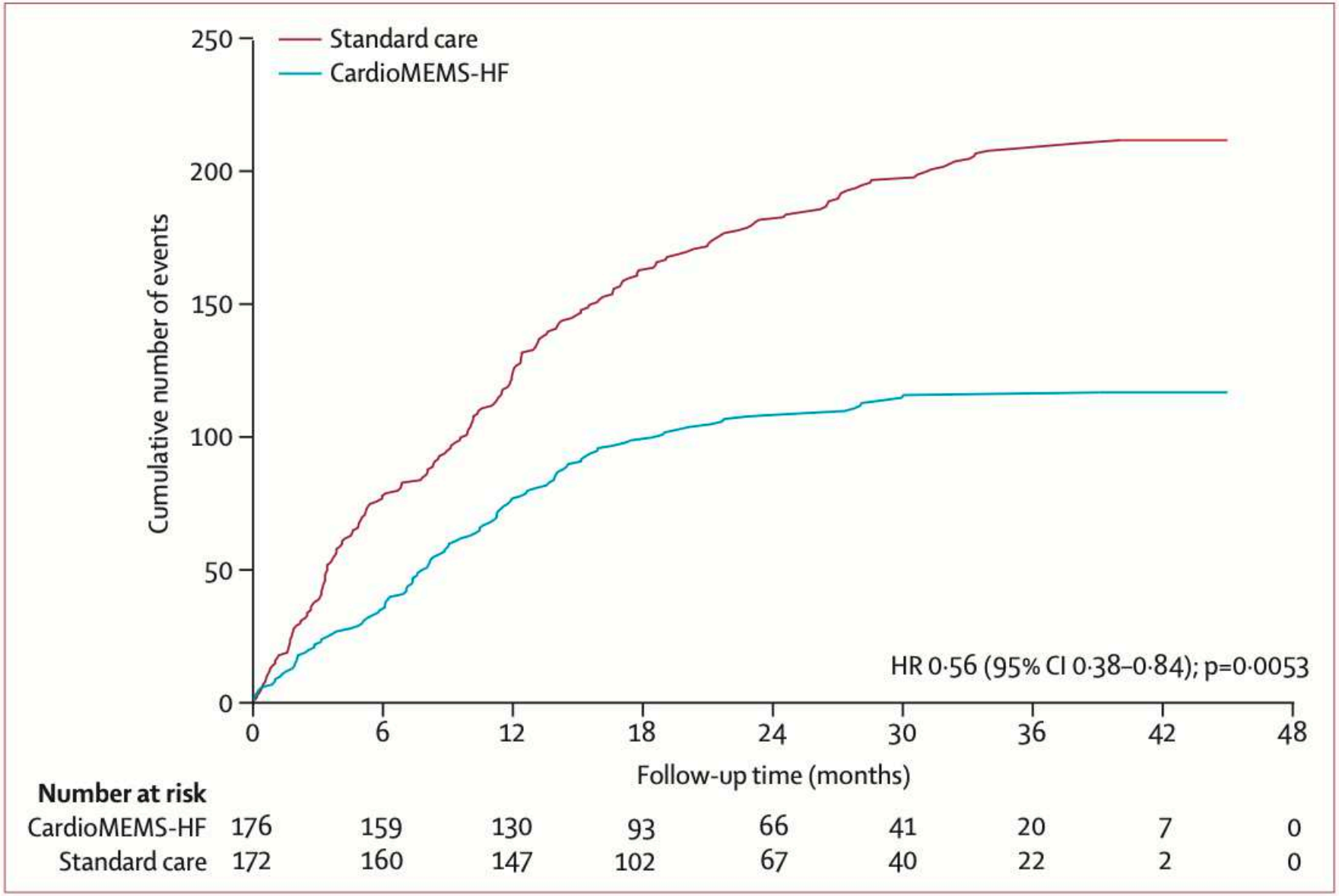
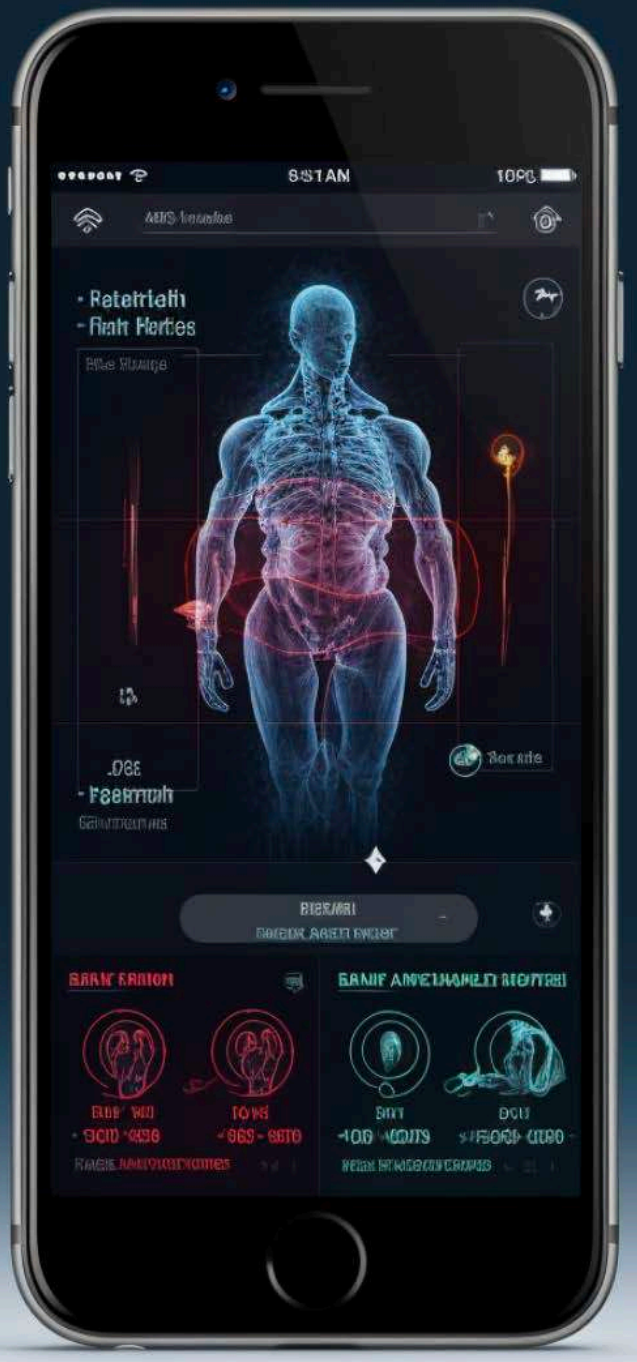


Figure 4: **Cumulative number of total heart failure hospitalisations (heart failure hospitalisations and urgent visits with necessity of iv diuretics) during entire follow-up**

colleagues,[14] "to master heart failure, first master congestion"; no invasive tool will improve patients without acting on pressures. Clearly, remote monitoring triggered this interaction between patient and caregiver as reflected in the number of drug changes that primarily targeted fluid status and the decline in mean pulmonary artery pressure and natriuretic peptide concentration. Most changes were made in diuretics, which could be in both directions, up-titration in case of hypervolaemia and down-titrations in case of hypovolaemia in a safe and controlled way.

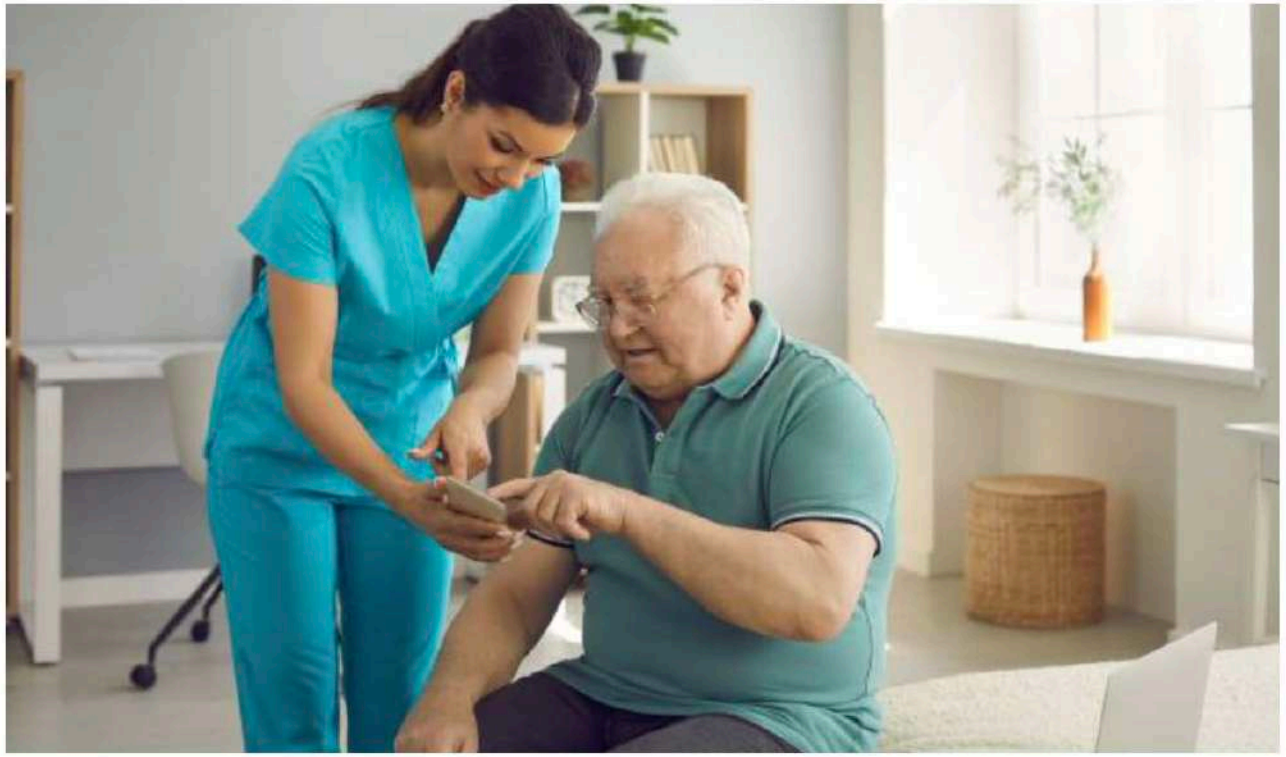
Our results might support the heart failure community to embrace e-health, digital technology, and telemonitoring to reduce the burden on our hospitals.



Remote Monitoring in Real-world HF Cuts All-Cause Mortality: TELESAT-HF

These data are observational but suggest that basic remote monitoring of weight and symptoms can cut patient risk.

by Michael O'Riordan | MAY 12, 2024



- NYHA functional class II or higher
- ↑BNP or NT-proBNP levels
- Those hospitalized within the past 12 months for HF decompensation
- In total, 5,357 patients were cared for with remote monitoring
- were propensity matched with 13,525 patients treated with usual care
- More than 55% of patients had a history of CHD
- >85% had HT, and 1/3 had DM

Girerd N, on behalf of the TELESAT investigators. Impact of a remote monitoring program on all-cause mortality of patients with heart failure: National, real-world evidence of the TELESAT study. Presented at: ESC Heart Failure 2024. May 11, 2024. Lisbon, Portugal.

TELESAT-HF

- The **reduction in all-cause mortality** (HR 0.64; 95% CI 0.59-0.70) **was seen** consistently in male and female patients as well as in young and old patients
- Those with limited digital literacy who reported their weight and symptoms via phone had a 46% lower risk of all-cause mortality compared with usual care whereas those monitored with the web-based platform had a 33% lower risk of death (P = 0.006 for interaction)
- That result was not really expected. The patients who were digitally illiterate seem to have a more sizeable reduction in events

Patients do not follow instructions

- 40-80% of verbal instructions are forgotten
- Lots of printed instructions

Doctors do not know if patients are uncontrolled or at risk

- There is no easy way to monitor patients at home

It leads to poor outcomes and increased costs

- ↑ LOS
- ↑ Rehospitalizations
- ↑ ER applications
- ↑ Costs

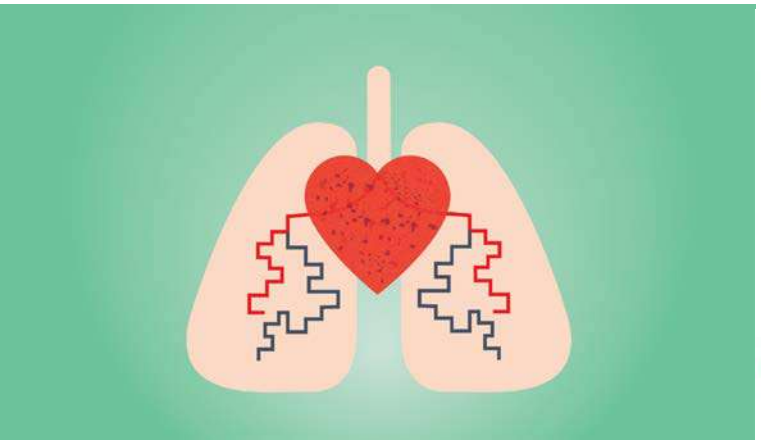
Solution: Remote Patient Management

AI Algorithms

Telehealth platform

Self management of patients

Pulmonary Arery Pressure



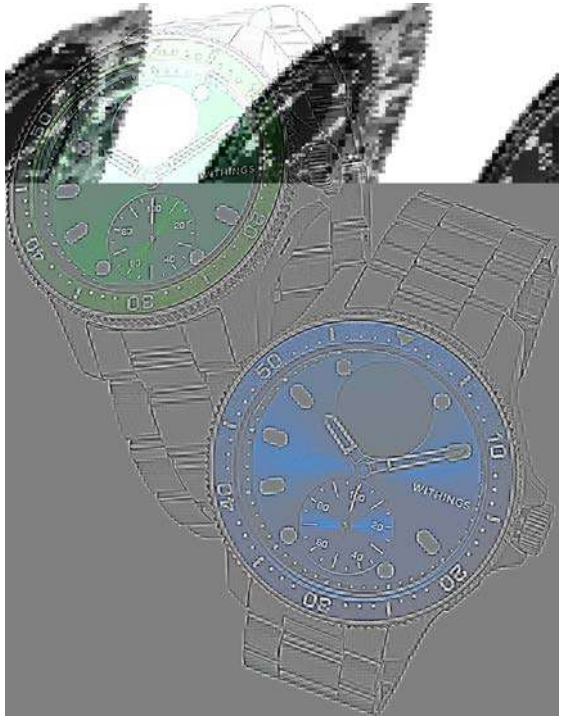
Lifestyle

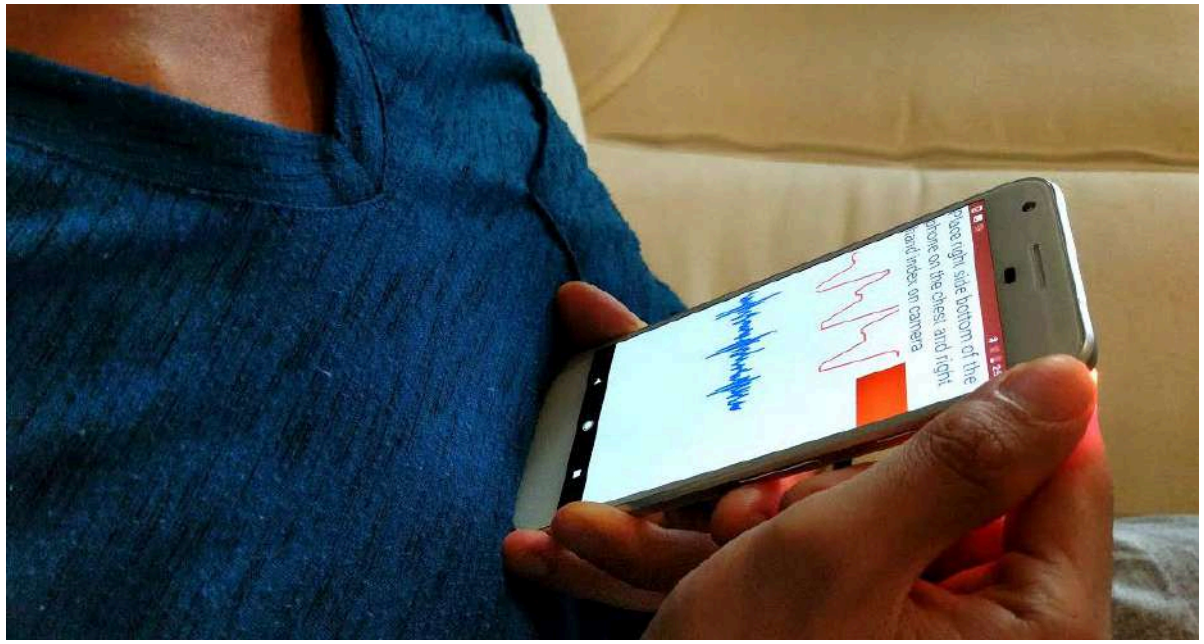
Fluid balance

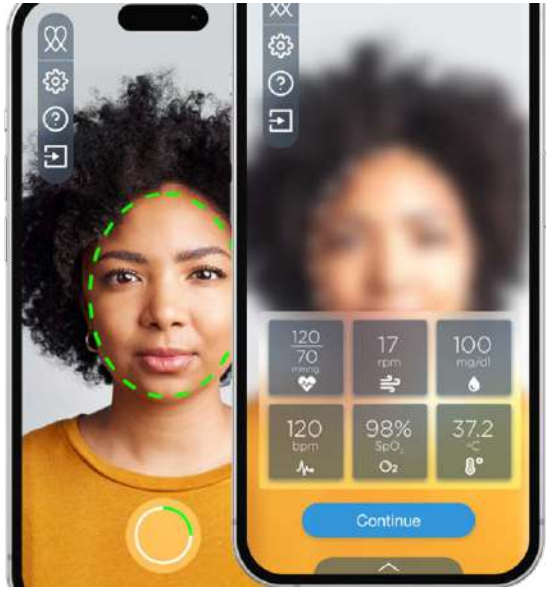
Medication adherence

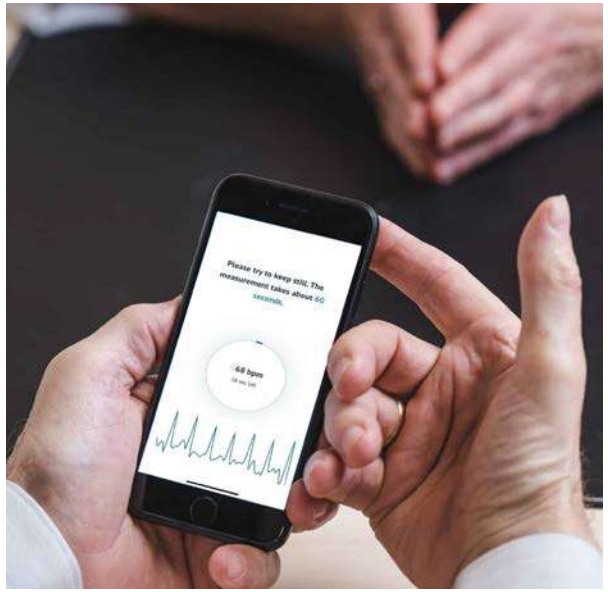
Connection with DR

biobeat Medical Smartmonitoring



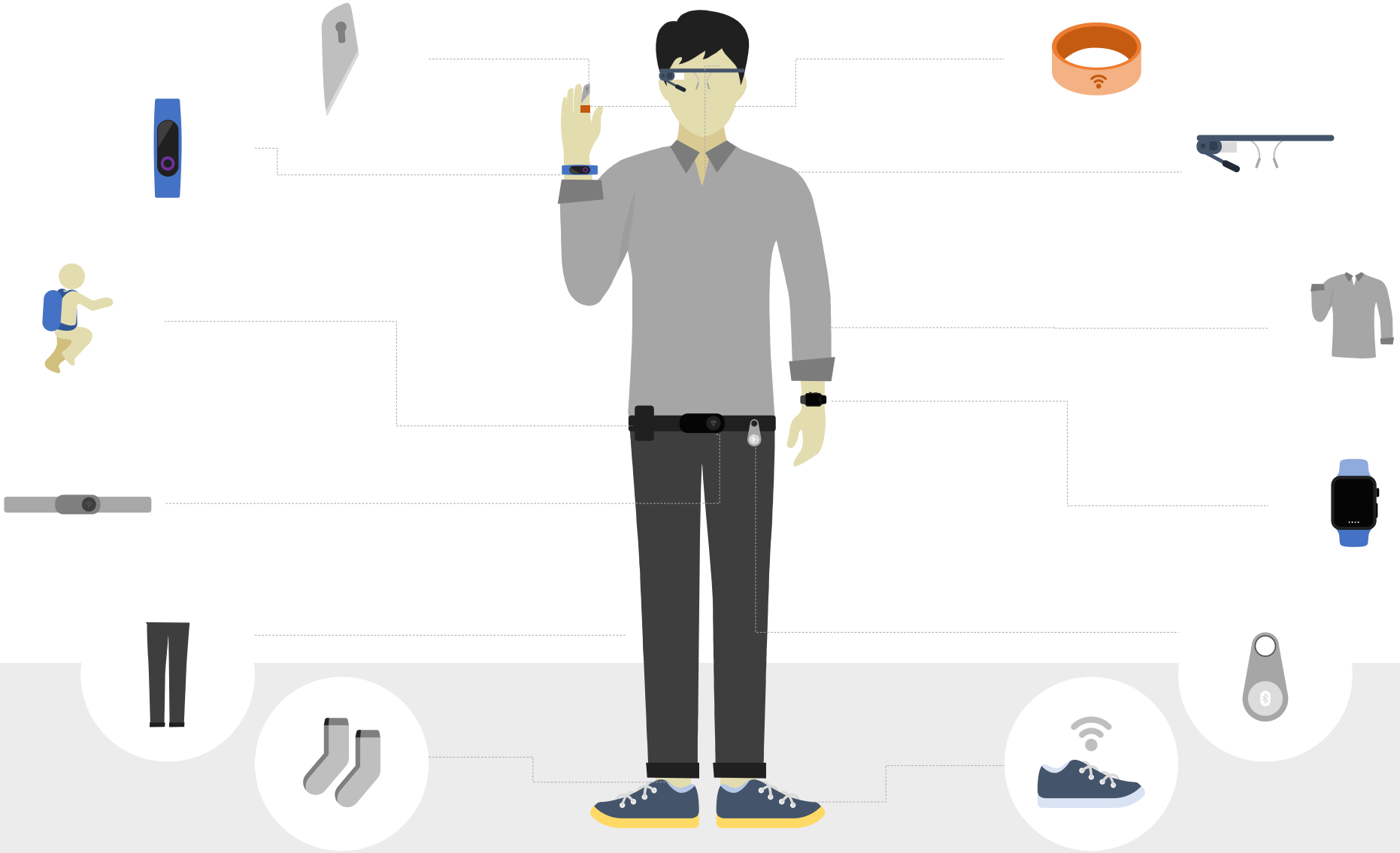



120
70
17
rpm
100
mg/dl
120
bpm
98%
37.2
Continue


Please try to keep still. The measurement takes about 60 seconds.
68 bpm


30

Wearables



Hospital@Home

Hospital at Home is a healthcare model that allows patients to receive acute care services in the comfort of their own homes instead of a traditional hospital setting

Main Advantages

- **Patient-Centered Care**
- **Cost-effective**
- **Resource efficient**

- It can help address capacity issues in hospitals during periods of peak demand
- It offers a valuable alternative for patients who need acute care but do not need the full resources of a hospital
- Patients treated at home experience fewer hospital-acquired infections, which promotes a safer and more comfortable recovery environment

Beyond the Device: Integration with Health Systems

I want to see the doctor

I can meet the doctor virtually

I can send my vitals to the doctor online

I have mobile apps and devices to solve my medical problem

Continually receiving data that optimizes my health

Syncronous

Asyncronous

Face to face appointments

Virtual visits

Connected devices

Automated tools for remote care

Personalized AI-powered platforms accessible from anywhere

ADAM

Pasient siyahısı

+ Pasient əlavə et

Ümumi baxış

Pasient siyahısı

Xəbərdarlıqları təyin edin

Parametrlər

Pasient axtarın

Hesabat

Hamısı 9 | Cihazlar 2 | Aktiv 7 | Tamamlanıb 0

Status	Pasient adı	Doğum tarixi	Xəbərdarlıqlar	Mesajlar	Ejeksiyon fraksiyası	NYHA	Son ötürülmə
Aktiv	Adam 4 (63, F)	1961-02-02			40%	II	02.02.2024, 17:13
Aktiv	Jamal (Adam3) (29, M)	1994-08-03	1	11	1%	I	24.05.2024, 13:59
Aktiv	Asker Mammadov (78, M)	1945-07-16		292	55%	I	Yox
Aktiv	Taleh Adam1 (65, M)	1959-05-20		42	45%	I	23.05.2024, 15:54
Aktiv	Adam 2 (Ibrahim Sivrikaya) (61, M)	1962-10-27	1	4	60%	I	27.05.2024, 23:42
Aktiv	Adam 6 (74, M)	1950-03-03			40%	II	02.02.2024, 16:31
Aktiv	Adam 5 (79, M)	1945-03-03			40%	III	02.02.2024, 15:54

Ən son yeniləmə 28.05.2024, 12:40

Rows per page: 10 1–7 of 7

ADAM

Ümumi baxış

Pasient siyahısı

Xəbərdarlıqları təyin edin

Parametrlər

Pasient siyahısı / Pasient tərəfi

Adam 2 (Ibrahim Sivrikaya)

Kişi, 61 y.o.

60%LVEF 1NYHA 26.5BMI

Birgə görünən xəstəliklər

Yüksək qan təzyiqi

İmplantasiya edilmiş cihazlar

-

Ətraflı məlumat

Hərəkat Aktiv

Xəbərdarlıqları təyin edin

Ürək çatışmazlığı dərman müalicəsi

- ARNI/RAAS
- MRA
- B.B
- SGLT2I

Uzaqdan izləmə | Pasient profili

SpO2 92 % səviyyəsindən aşağıdır	25.05.2024 21:25	Tamamlandı	
Sistem. Qan təzyiqi 140 mmHg səviyyəsindən yüksəkdir	27.05.2024 15:19	Tamamlandı	
Xəstə simptom sorğularını təqdim etməyib	24.05.2024 05:02	Tamamlandı	

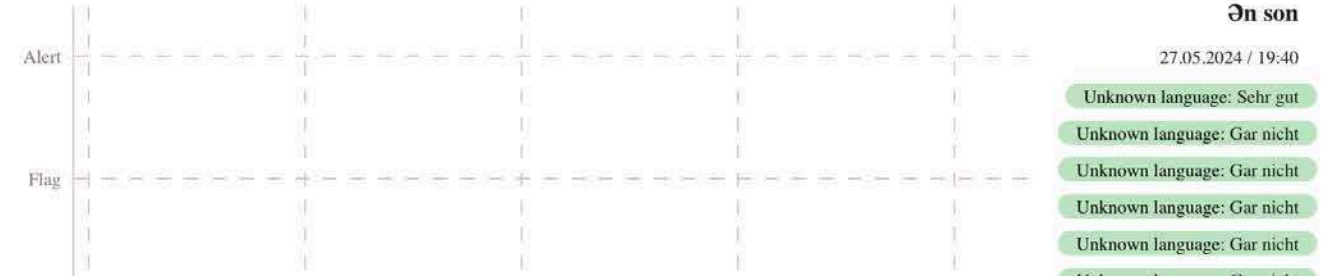
Keçmiş xəbərdarlıqlar

Sağlamlıq məlumatları

1 gün | 3 gün | 1 həftə | 1 ay | 3 ay | 1 il

Son yeniləmə: 28.05.2024, 12:40

Simptomlar



Ən son

27.05.2024 / 19:40

- Unknown language: Sehr gut
- Unknown language: Gar nicht
- Unknown language: Gar nicht
- Unknown language: Gar nicht
- Unknown language: Gar nicht

Pasient təsbitləri

Təsbitlərinizi sənədləşdirin və ya həmkarınız üçün bir qeyd yazın.

Yadda Saxla

Hamısı | Dərman | Qeydlər | Xəbərlər

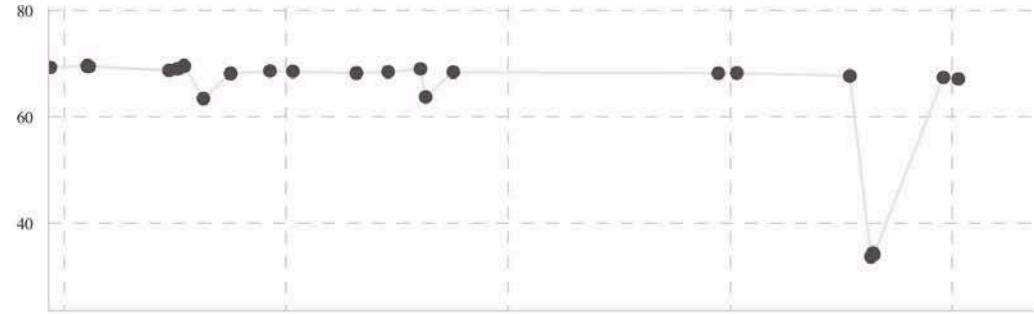
- **25.05.2024** Xəbərlər -dan Mirzoyev
- **25.05.2024** Xəbərlər -dan Mirzoyev
- **18.05.2024** Xəbərlər -dan Mirzoyev
- **15.05.2024** Xəbərlər -dan Mirzoyev

ADAM

- Ümumi baxış
- Pasient siyahısı
- Xəbərdarlıqları təyin edin

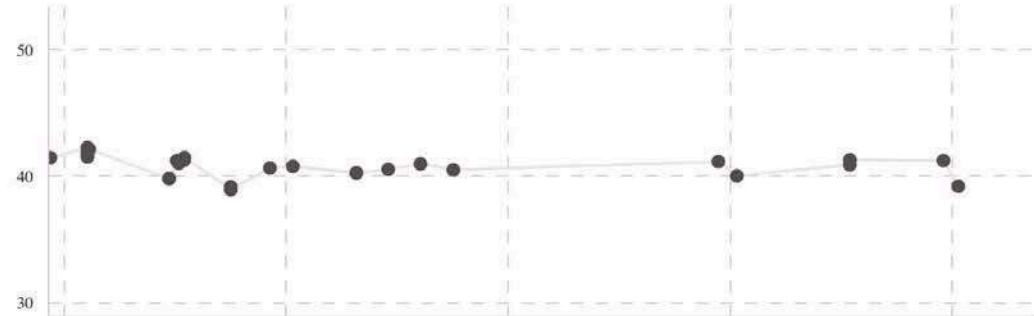
- Parametrlər
- Dəstək

Çəki



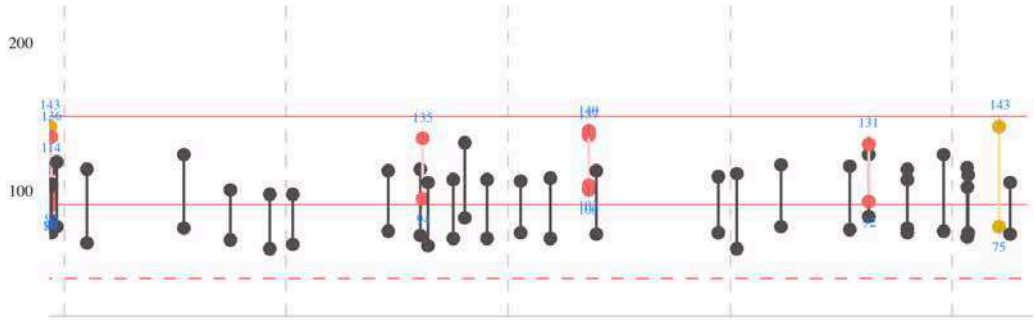
67 kg

Su miqdarı



39 %

Qan təzyiqi



105/70 mmHg

- **09.05.2024** Xəbərlər -dan Mirzoyev
- **08.05.2024** Xəbərlər -dan Mirzoyev
- **01.05.2024** Xəbərlər -dan Mirzoyev
- **27.04.2024** Xəbərlər -dan Mirzoyev
- **28.12.2023** Dərmanların tənzimlənməsi
- **28.12.2023** Dərmanların tənzimlənməsi
- **28.12.2023** Dərmanların tənzimlənməsi
- **28.12.2023** Xəbərlər -dan Mirzoyev
- **18.11.2023** Dərmanların tənzimlənməsi
- **11.11.2023** Dərmanların tənzimlənməsi

ADAM

Ümumi baxış

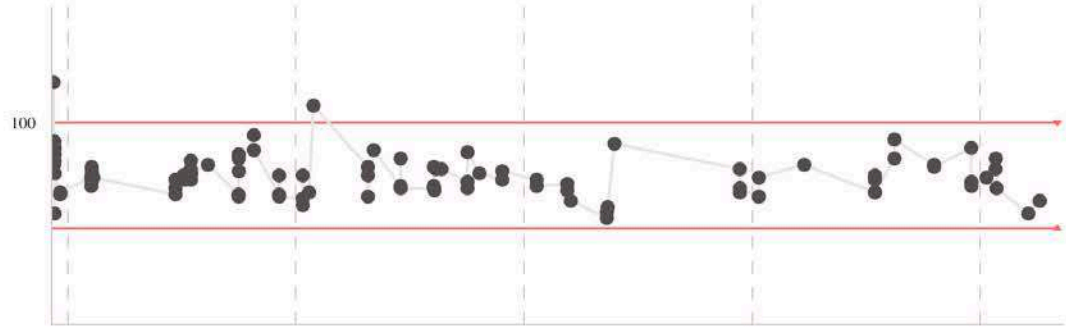
Pasient siyahısı

Xəbərdarlıqları təyin edin

Parametrlər

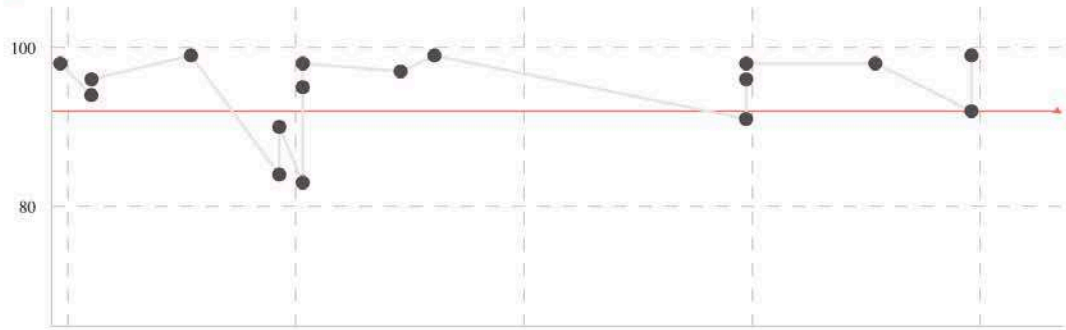
Dəstək

Nəbz



63
bpm

SpO2



99
%

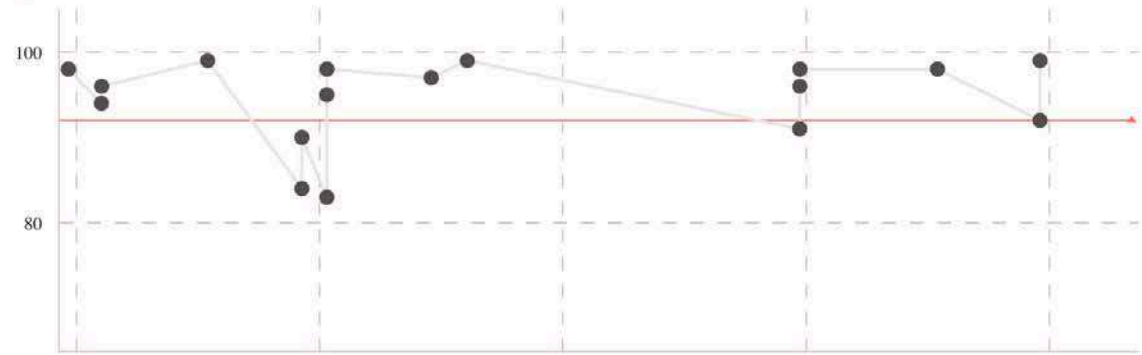
EKQ

Son EKQ-yə baxın

Öncədən qiymətləndirmə	Ölçmə tarixi	Nəbz [bpm]	PR [ms]	QRS [ms]	QT [ms]	QTc [ms]
Atrial fibrilasiya yoxdur	25.05.2024 - 21:24	70	53	123	323	348
Atrial fibrilasiya yoxdur	22.05.2024 -	67	73	116	360	380

Ümumi baxış
Pasient siyahısı
Xəbərdarlıqları təyin edin

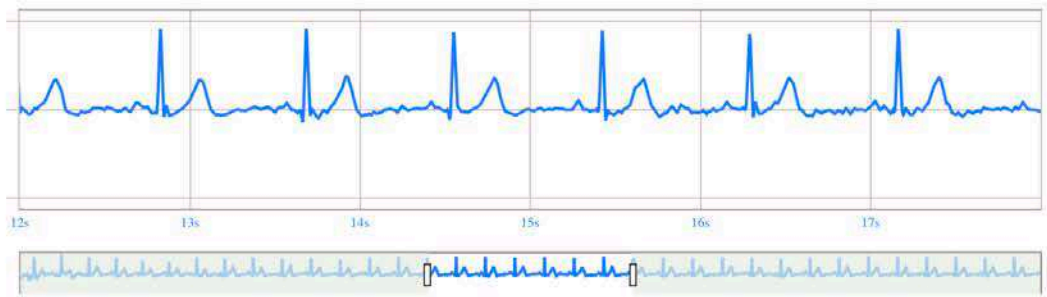
SpO2



99
%

EKQ

Geri



Atrial fibrilasiya yoxdur

70 bpm

30 saniyə

25.05.2024 - 21:24

Parametrlər
Dəstək

Difficulties and Challenges

- Data privacy and security
- Digital Divide
- Training of health care providers
- Legal issues
- Patient involvement
- Solutions and Strategies:

Solving these problems requires a combination of policy, technology and education

Population Health Management

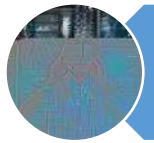
Not Just Paradigm Shift

The Future of Healthcare

Evidence Based Medicine

Value-Based Financing

Patient Empowerment



Deeper Penetration of New Technologies

Personalised Medicine

Shift of health care out of hospital