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Monitoring of HF Patients with Devices

세종병원 김경희

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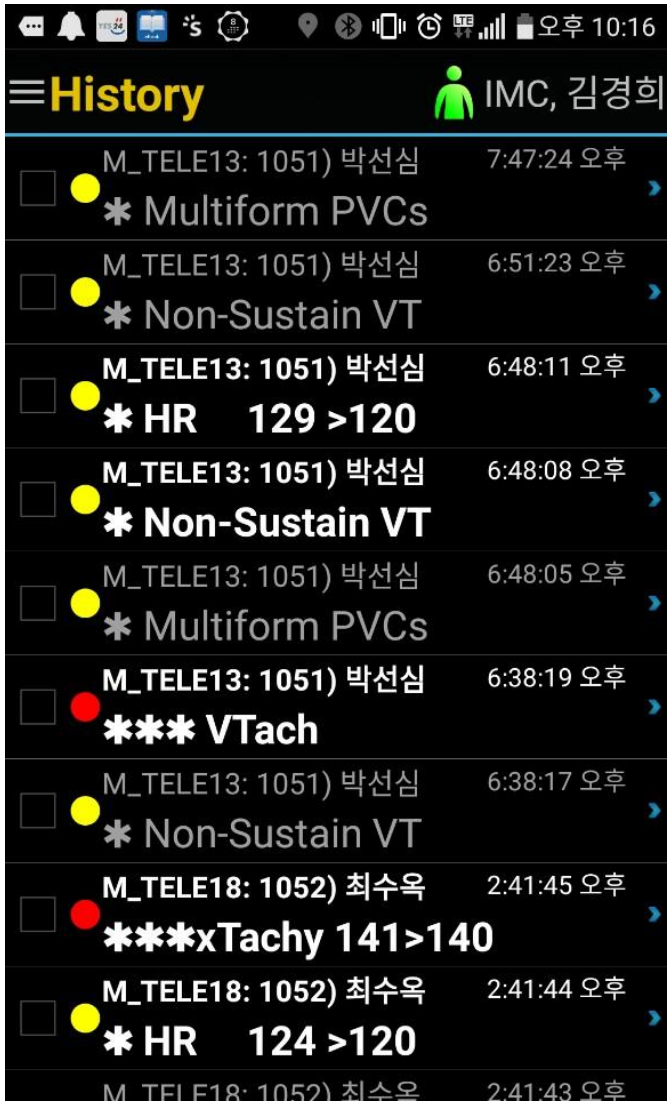
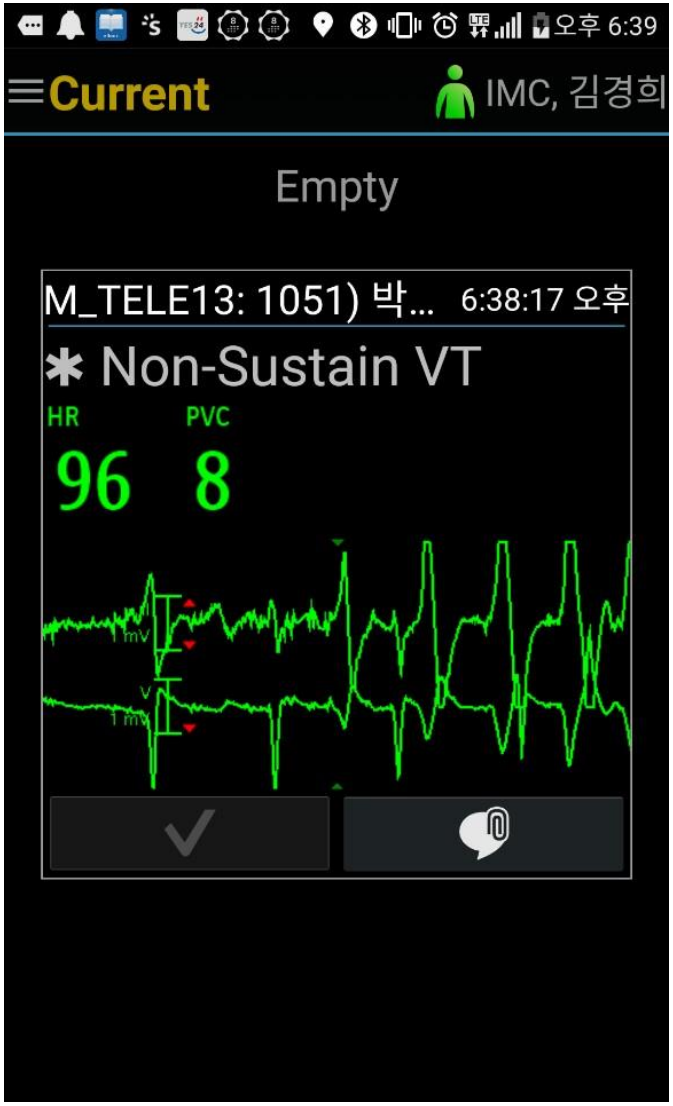
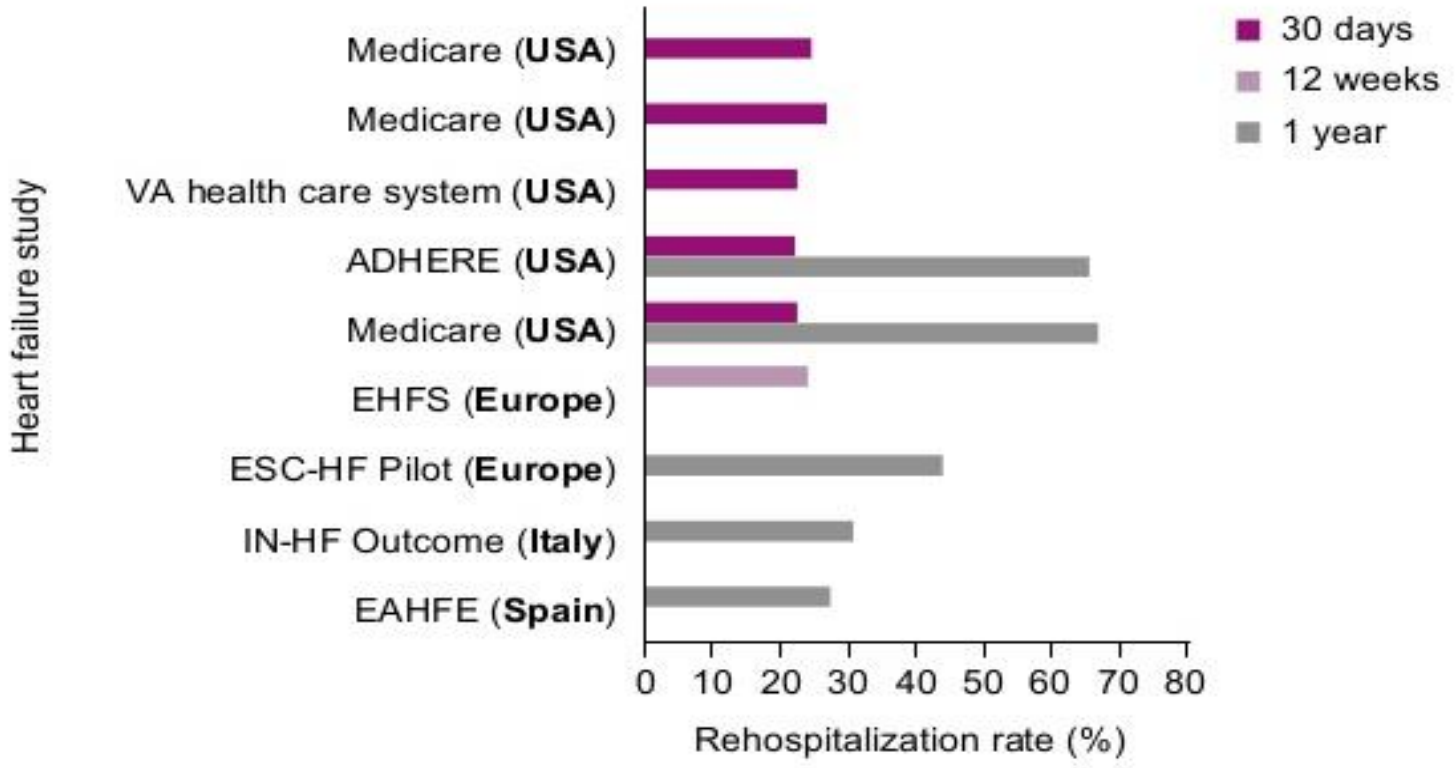

오후 10:16
History
IMC, 김경희
M_TELE13: 1051) 박선심 7:47:24 오후
✱ Multiform PVCs
M_TELE13: 1051) 박선심 6:51:23 오후
✱ Non-Sustain VT
M_TELE13: 1051) 박선심 6:48:11 오후
✱ HR 129 >120
M_TELE13: 1051) 박선심 6:48:08 오후
✱ Non-Sustain VT
M_TELE13: 1051) 박선심 6:48:05 오후
✱ Multiform PVCs
M_TELE13: 1051) 박선심 6:38:19 오후
✱✱✱ VTach
M_TELE13: 1051) 박선심 6:38:17 오후
✱ Non-Sustain VT
M_TELE18: 1052) 최수옥 2:41:45 오후
✱✱✱xTachy 141>140
M_TELE18: 1052) 최수옥 2:41:44 오후
✱ HR 124 >120


오후 6:39
Current
IMC, 김경희
Empty
M_TELE13: 1051) 박... 6:38:17 오후
✱ Non-Sustain VT
HR PVC
96 8

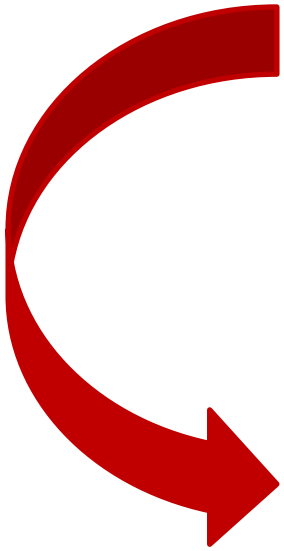
High hospital readmission rates of patients with AHF



Initial insult

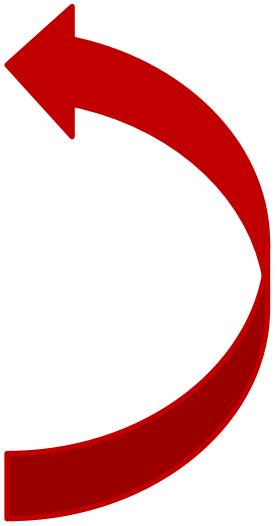
(e.g. infections, non-compliance with diet or medications, hypertension, ischemia, arrhythmia)

Fluid retention
Venous congestion



Mechanisms:

- **Endothelial**
- **Neurohormonal**
- **Renal**
- **Cardiac**



Fluid retention
Venous congestion
(Progressive over weeks)

ADHF

So, we should pay more attention to heart failure ' PREVENTION and to its TREATMENT, to optimize the treatment conditions, not only for the doctor but also for the patient [2].

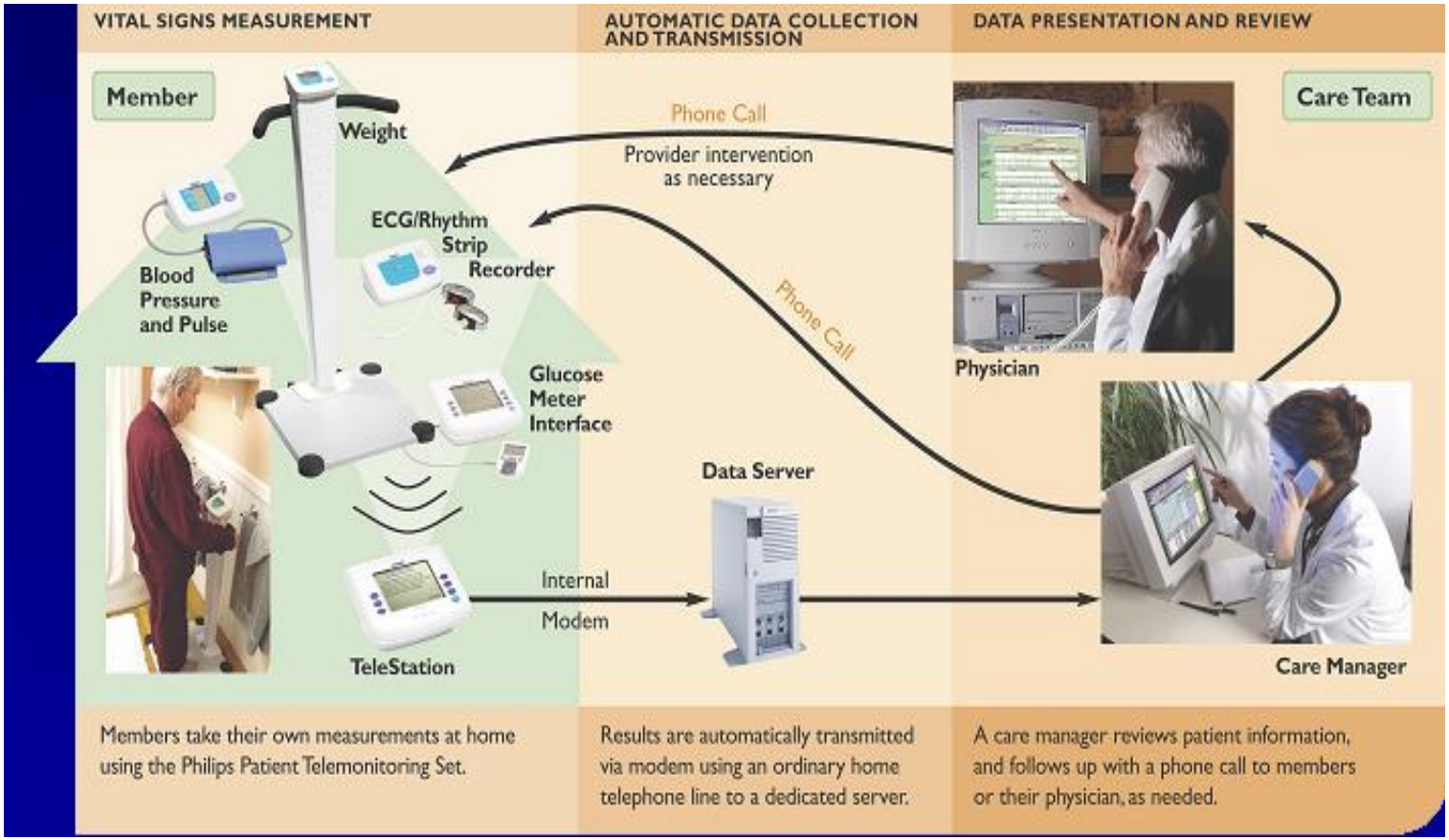
Not wasting time with stable patients, without complications, so that the doctors can pay more attention to more urgent and serious patients [2]

Better quality of life [2]

Jung W, Rillig A, Birkemeyer R, Miljak T, Meyerfeldt U. 2008.

TEN-HMS

The Trans-European Network–Home-Care Management System
Patients about to be discharged from hospital after an exacerbation of chronic heart failure



54% of Patients Aged >70 years

JACC 2005

Outpatient monitoring for early detection of ADHF is better

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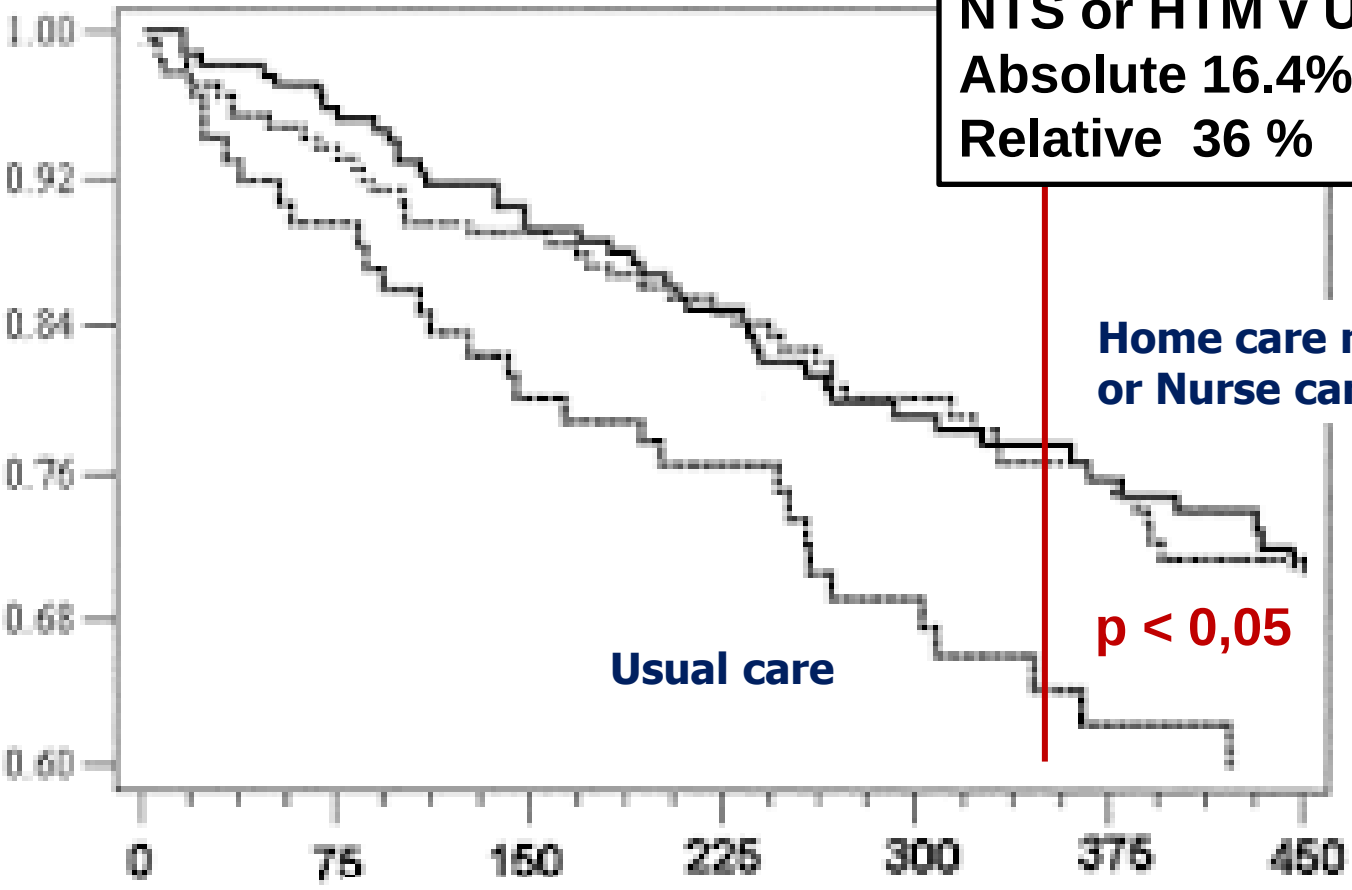
Survival distribution function



JACC 2005

Structured Telephone Support

n = 5,563
(Cochrane Review)

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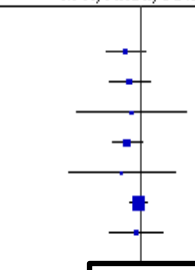
Mortality

Study or Subgroup	Intervention Events	Intervention Total	Usual Care Events	Usual Care Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Barth 2001	0	17	0	17		Not estimable
Cleland 2005(Struct Tele)	27	173	20	85	7.8%	0.66 [0.40, 1.11]
DeBusk 2004	21	228	29	234	8.3%	0.74 [0.44, 1.26]
DeWalt 2006	3	62	4	65	1.1%	0.79 [0.18, 3.37]
Galbreath 2004	54	710	39	359	15.0%	0.70 [0.47, 1.04]
Gattis 1999 (PHARM)	3	90	5	91	1.4%	0.61 [0.15, 2.46]
GESICA 2005 (DIAL)	116	760	122	758	35.4%	0.95 [0.75, 1.20]
Laramee 2003	13	141	15	146	4.3%	0.90 [0.44, 1.82]
Mortara 2009 (Struct Tele)	9	106	9	160	2.1%	1.51 [0.62, 3.68]
Rainville 1999	1	19	4	19	1.2%	0.25 [0.03, 2.04]
Riegel 2002a	16	130	32	228	6.7%	0.88 [0.50, 1.54]
Riegel 2006	6	70	8	65	2.4%	0.7(
Sisk 2006	22	203	22	203	6.4%	1.0(
Tsuyuki 2004	16	140	12	136	3.5%	1.3(
Wakefield 2008a	25	99	11	49	4.3%	1.1(
Total (95% CI)		**2948**		**2615**	**100.0%**	**0.88**
Total events	332		332			

Risk Ratio M-H, Fixed, 95% CI



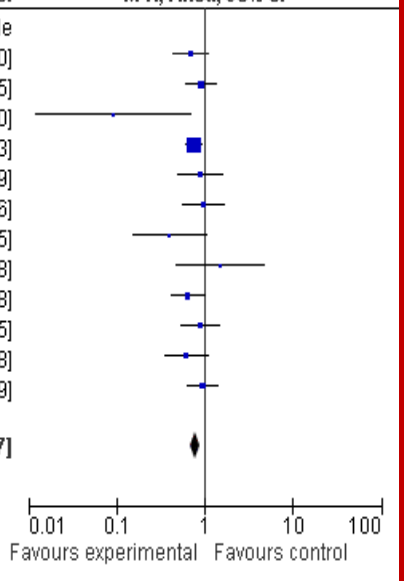
HR 0.88 (0.76-1.01); p=0.08

New Trials
- Tele-HF
- TEHAF

All-Cause Hospitalisation

Study or Subgroup	Intervention Events	Intervention Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Barth 2001	0	17	0	17		Not estimable
Cleland 2005(Struct Tele)	34	173	24	85	7.2%	0.70 [0.44, 1.10]
DeBusk 2004	38	228	43	234	9.5%	0.91 [0.61, 1.35]
Gattis 1999 (PHARM)	1	90	11	91	2.4%	0.09 [0.01, 0.70]
GESICA 2005 (DIAL)	128	760	169	758	37.8%	0.76 [0.61, 0.93]
Laramee 2003	18	141	21	146	4.6%	0.89 [0.49, 1.59]
Mortara 2009 (Struct Tele)	18	106	28	160	5.0%	0.97 [0.57, 1.66]
Rainville 1999	4	19	10	19	2.2%	0.40 [0.15, 1.05]
Ramachandran 2007	6	25	4	25	0.9%	1.50 [0.48, 4.68]
Riegel 2002a	23	130	63	228	10.2%	0.64 [0.42, 0.98]
Riegel 2006	21	70	22	65	5.1%	0.89 [0.54, 1.45]
Sisk 2006	18	203	29	203	6.5%	0.62 [0.36, 1.08]
Tsuyuki 2004	37	140	38	136	8.6%	0.95 [0.64, 1.39]
Total (95% CI)		**2102**		**2167**	**100.0%**	**0.77 [0.68, 0.87]**
Total events	346		462			

Risk Ratio M-H, Fixed, 95% CI



HR 0.77 (0.68-0.87.01); p<0.0001

Inglis et al 2010

The Question of

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The concept of outpatient monitoring for early detection and treatment of ADHF is not new.

which parameters to monitor

&

what specific detection strategies

Heart failure require **IECD** [4]

This way, doctors could follow patients more carefully [4]

- Pacemakers
- ICDs (implantable cardioverter defibrillators)
- CRTs (cardiac resynchronization devices)
- Loop recorders
- Implantable hemodynamic monitors

IECD have the ability to [4]:

1. restore normal cardiac activation sequence
2. detect and treat a malignant arrhythmia, by means of electrical therapy
3. maintain rhythm
4. provide cardiac resynchronization therapy
5. prevent sudden cardiac death

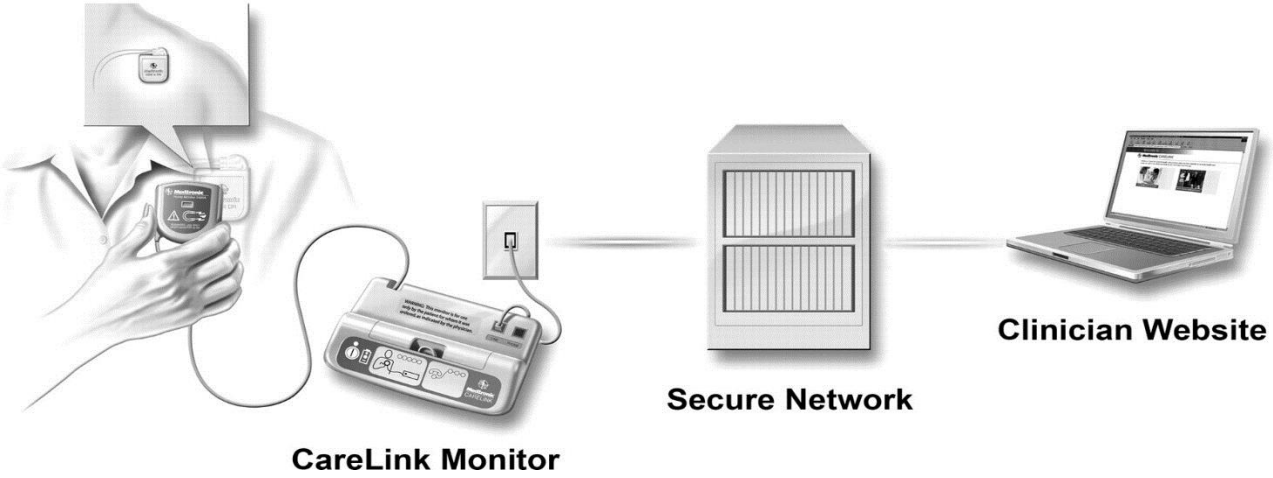
References

[4] Costa PD, Rodrigues PP, Reis AH, Costa-Pereira A. 2010.

Since the 70s

REMOTE MONITORING

- Has been used in the follow-up of patients with IECD in alternative to monitoring on a presential consultation [4, 5, 7, 8]



- It consists on the use of electronic information and communication technologies to provide h ealth care at distance and allow remote decisions, in order of maintaining or improving patient s' health [8]

References

[4] Costa PD, Rodrigues PP, Reis AH, Costa-Pereira A. 2010.
[5] Guevara, Valdivia ME. 2009.
[7] Burri H, Senouf D. 2009.
[8] Angaran DM. 1999.

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The rapidly expanding role of

cardiac implantable electronic devices (CIEDs)

in HF patients presents an opportunity

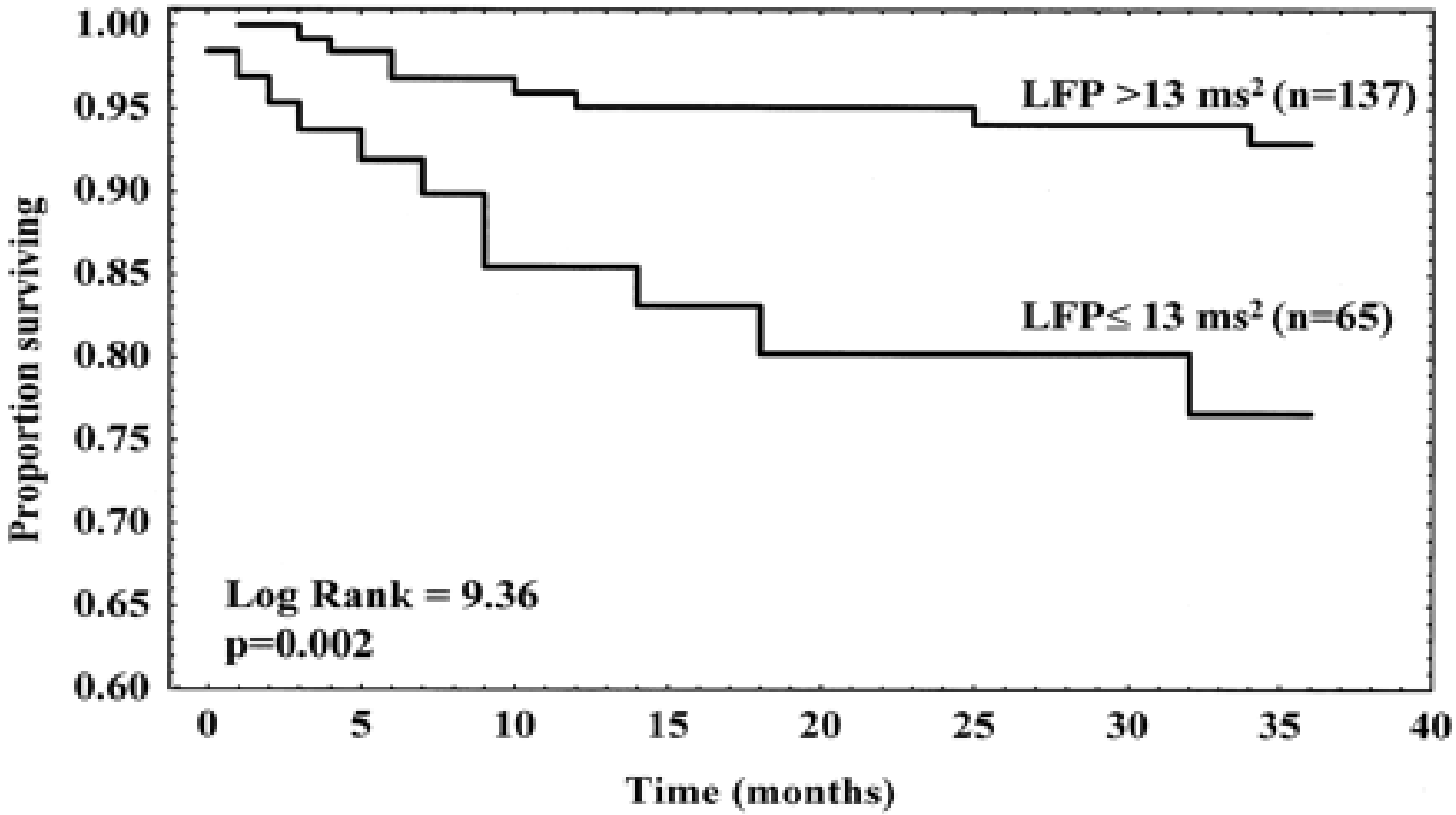
to broaden the paradigm of

outpatient HF monitoring

Sensor modalities for Heart Failure Monitoring

Sensors	Examples
Currently available sensors	
Heart rate derivatives	Mean heart rate, nocturnal heart rate Heart rate variability (SDAAM, SDANN) HRV foot print
Accelerometers	Physical activity level
Impedance monitors	RV-CAN LV-RV, LV-can impedance Minute ventilation
Hemodynamic	Right ventricular pressure RV dP/dTmax (ePAD) Left atrial pressure (heart POD) Pulmonary artery pressure (Champion)
Cardiac output	Doppler RV O2 saturation monitor
Heart sounds	Peak endocardial acceleration

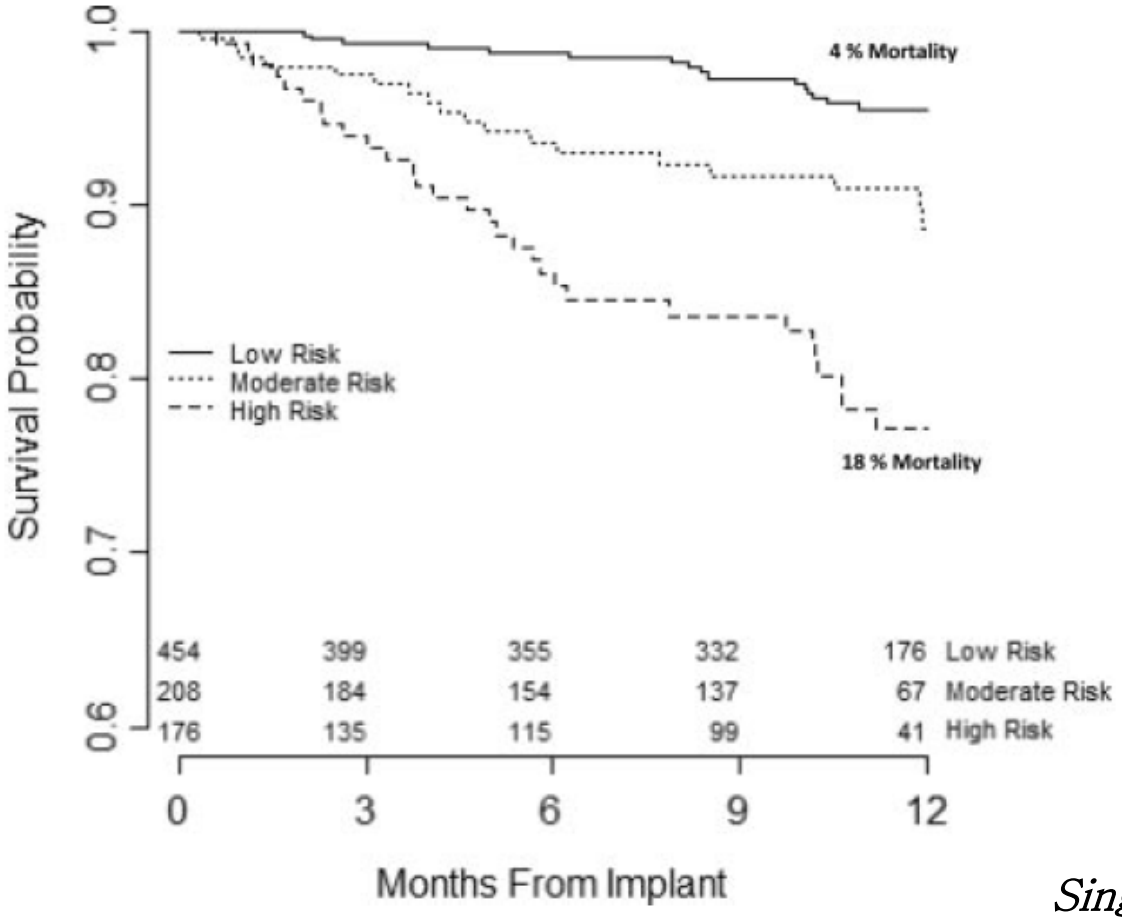
Reduced short-term HRV during controlled breathing is a powerful predictor of sudden death in patients with CHF



HRV can be measured from CIEDs with atrial leads by determining the standard deviation of 5-minute median atrial-atrial intervals (SDAAM) or consecutive ventricular (N-N) intervals (SDANN) over a 24-hour period. Periods of atrial pacing or high atrial rate episodes,including atrial fibrillation, are excluded from HRV analysis

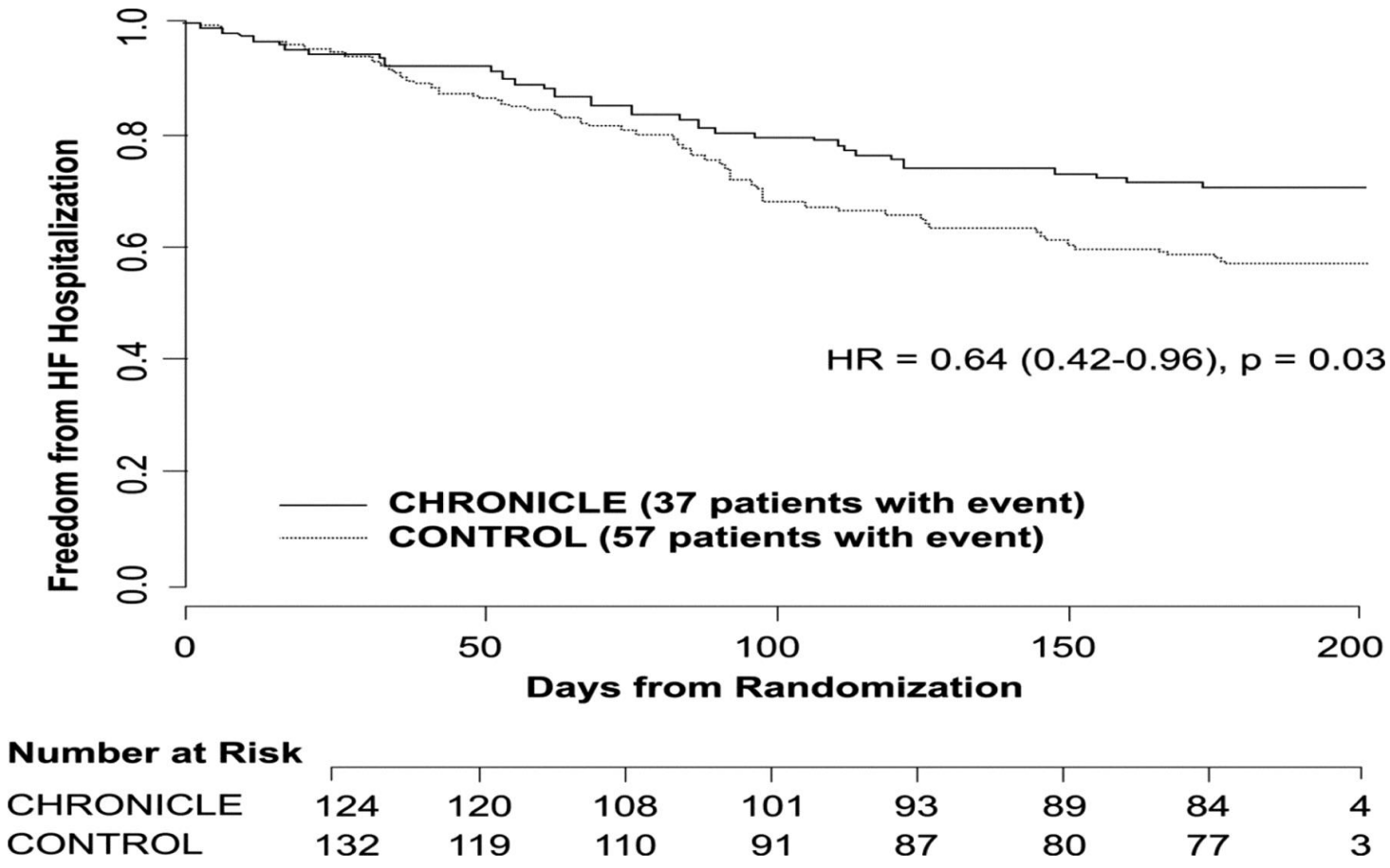
Circulation 2003

Prognostic utility of a risk score based on 4 simple sensor-derived parameters (SDANN, HRV footprint, HR, and physical activity)



Singh JP, Europace 2009

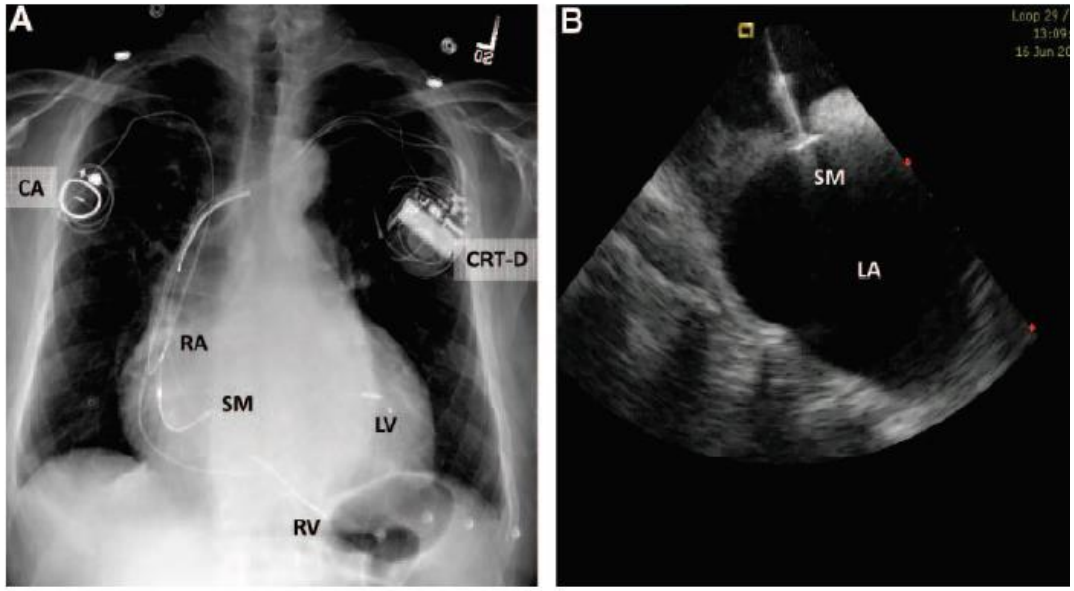
Significant improvement in HF hospitalization associated with chronic RVP monitoring (Chronicle IHM) compared with standard HF therapy

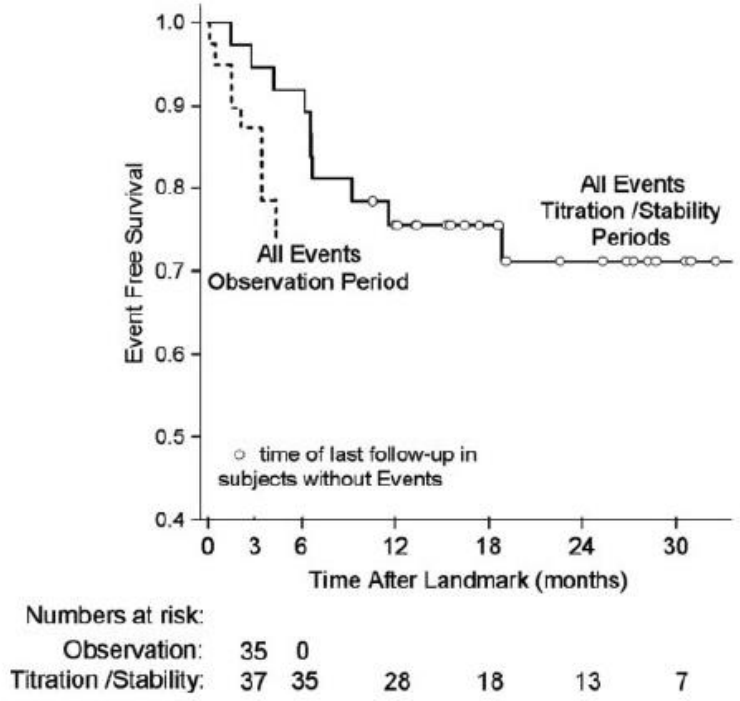


A commercially available implantable pressure sensor (Chronicle IHM, Medtronic Inc, Minneapolis, Minn)

JACC 2010

Left atrial pressure monitoring compared with the observational period of standard HF care



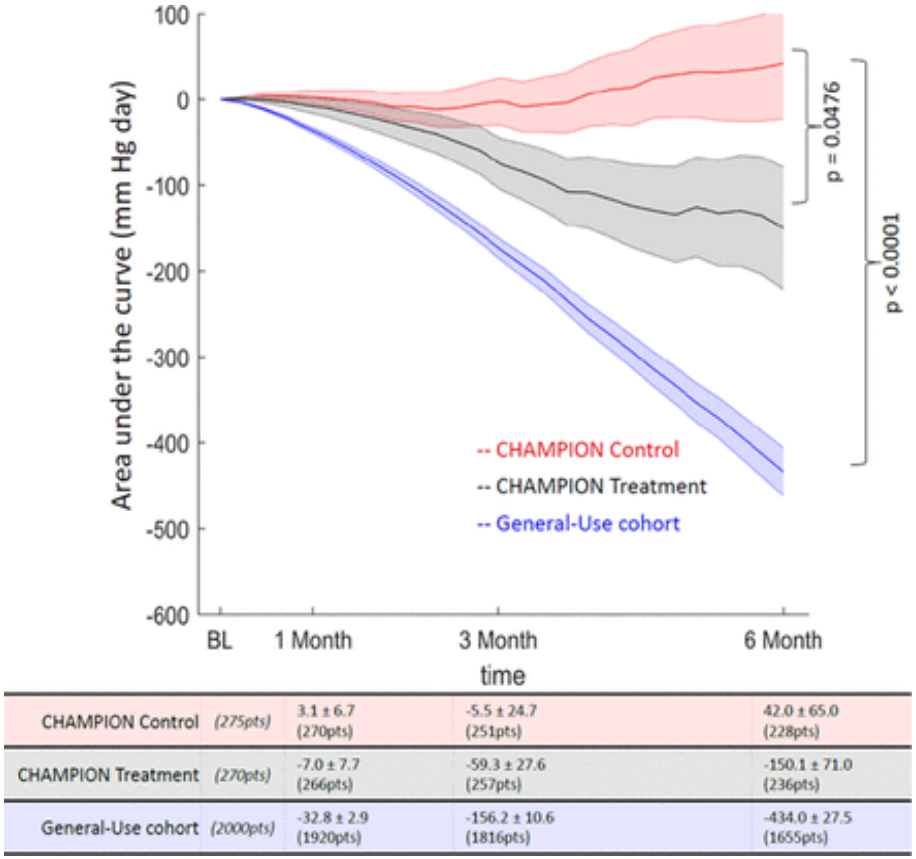


The HeartPOD (St Jude Medical Inc, Minneapolis, Minn) is a permanently implantable LAP sensor inserted during transseptal cardiac catheterization

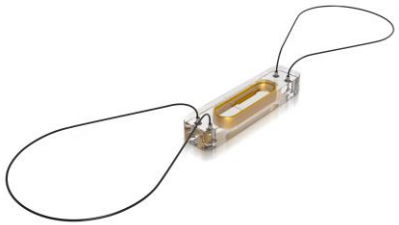
Circulation 2010

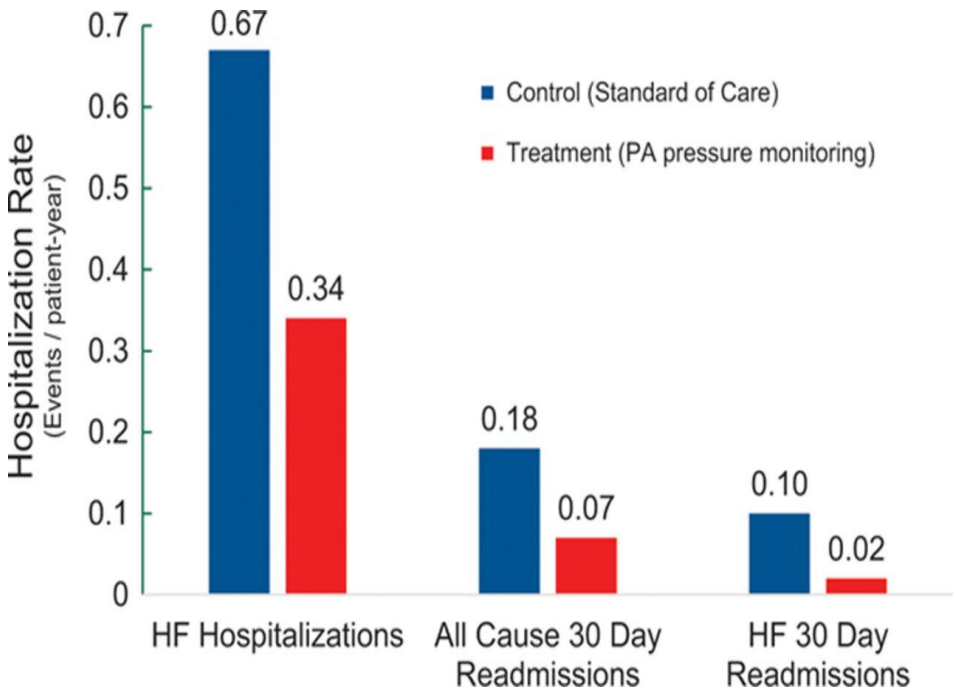
PAP-guided management demonstrated a significant 30% relative risk reduction in HF hospitalization at 6 months

Champion, CardioMEMS, Atlanta, Ga



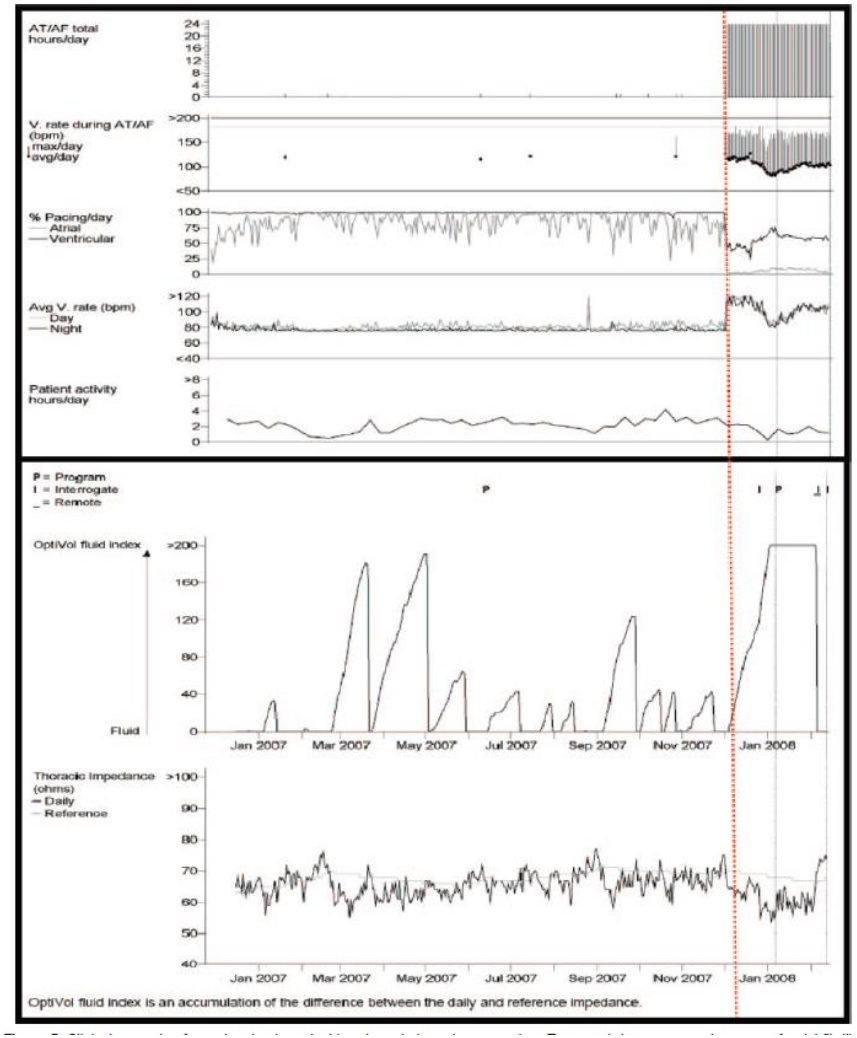
CHAMPION Control	(275pts)	3.1 ± 6.7 (270pts)	-5.5 ± 24.7 (251pts)	42.0 ± 65.0 (228pts)
CHAMPION Treatment	(270pts)	-7.0 ± 7.7 (266pts)	-59.3 ± 27.6 (257pts)	-150.1 ± 71.0 (236pts)
General-Use cohort	(2000pts)	-32.8 ± 2.9 (1920pts)	-156.2 ± 10.6 (1816pts)	-434.0 ± 27.5 (1655pts)





2011 Lancet

Impedance Monitoring

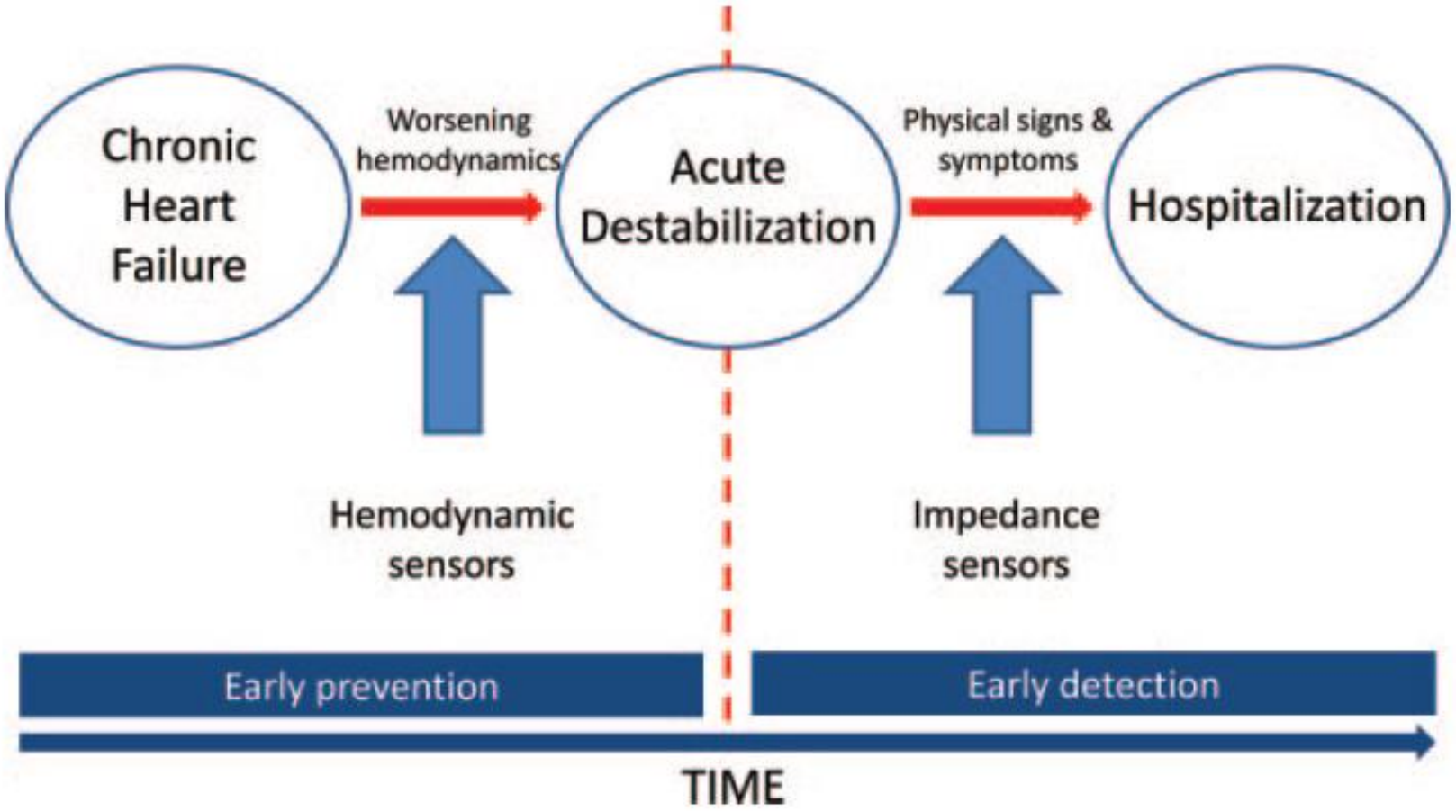


A drop in the electric impedance (ohms) across the thoracic cavity reflects an increase in tissue fluid content in the interpositioned pulmonary tissue and signals a state of volume overload and fluid retention.

False positive and negative .

Mild signs or symptoms of congestive HF and may trigger changes in treatment but do not necessarily lead to hospitalization for ADHF

Theoretical paradigm for a multiple sensor strategy



Opportunities for Future Sensor Development

- Chemicals PO2, PCO2, pH
- Electrolytes, glucose
- Biomarkers Natriuretic peptides (BNP, NT-proBNP, ANP)
  - Inflammatory markers (TNF-a, IL-6, hsCRP)
  - Troponin
- Metabolomic/signalingcascades
  - Apoptosis/caspase signaling
  - Glycolysis
- Microtubule assembly pathways

Summary

- The concept of outpatient monitoring for early detection and treatment of ADHF is very important.

- The greatest potential for CIEDs in HF management lies in the ability to directly couple both sensor and effector functions within the device

- The expanding role of implantable sensors is leading to a paradigm shift in HF management.

- Implantable sensors will become part of routine clinical care, and, when coupled with remote monitoring, will allow the practice of a more personalized form of medicine and enable early, automated therapeutic interventions and improve clinical outcomes.

Thank you for your attention

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