9th CHALLENGES in CARDIOLOGY

JUNE 28th - 29th 2019

Palace Hotel Monte Real

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Centro Hospitalar de Entre o Douro e Vouga

29th June 2019

9th CHALLENGES in CARDIOLOGY

MONITORIA

MOnitoring NonInvasively To Overcome mortality Rates of heart Insufficiency on Ambulatory

- State-of-the-art multimodal array of sensors that will provide **real time home monitoring** of critical vital and electrophysiological, hemodynamic and chemical signs, physical activity levels and transthoracic impedance data, in chronic heart failure patients.

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Heart Failure (HF)

- Worldwide HF **incidence is increasing** in parallel to cardiovascular risk factor
- **Portugal shows similar trends**
- On our Center, near **47% of internal medicine admissions** are due to HF

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Heart Failure (HF)

GDH	Designação GDH	Qtd. Episódios	% no total de episódios	% Acumulada
640	Recém-nascido, peso ao nascer > 2499g, normal ou com outros problemas	57022	7,09%	7,09%
560	Parto vaginal	46936	5,83%	12,92%
139	Outras pneumonias	33846	4,21%	17,12%
194	Insuficiência cardíaca	21048	2,62%	19,74%
540	Parto por cesariana	19111	2,37%	22,11%
463	Infeções do rim e/ou vias urinárias	18318	2,28%	24,39%
45	Acidente vascular cerebral e/ou oclusão pré-cerebral com enfarte	16688	2,07%	26,46%
144	Sinais, sintomas e/ou diagnósticos minor respiratórios	14617	1,82%	28,28%
263	Colecistectomia laparoscópica	10028	1,25%	29,52%
308	Procedimentos na anca e/ou fémur por traumatismo exceto substituição da articulação	9209	1,14%	30,67%
Total de episódios		**804815**	**100,00%**	**100,00%**

Fonte: BIMH

- **30% of deaths** among internal medicine patients relate to chronic HF decompensation.
- Mortality rates of HF patients needing hospitalization are remarkable, and at our center is aproximately 15%

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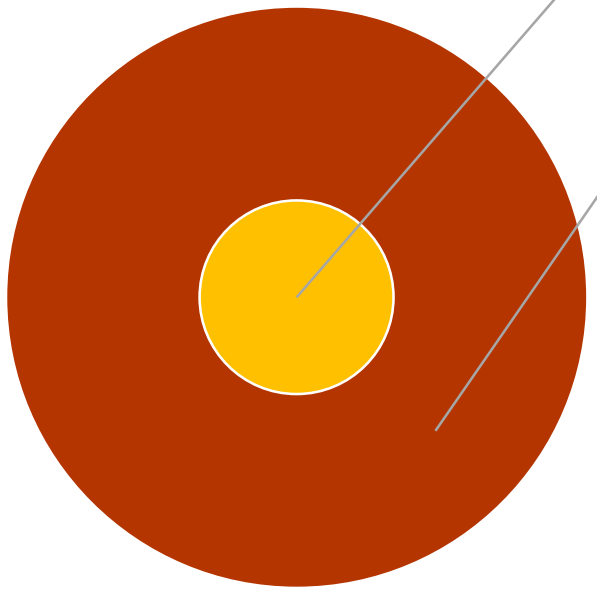
MONITORIA and GENICA project



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- Real-time monitoring of critical variables
- Patient – Emergency dispatch – Physician communication enabler
- Improve quality of life and reduce morbidity/mortality
- Generate data for future research

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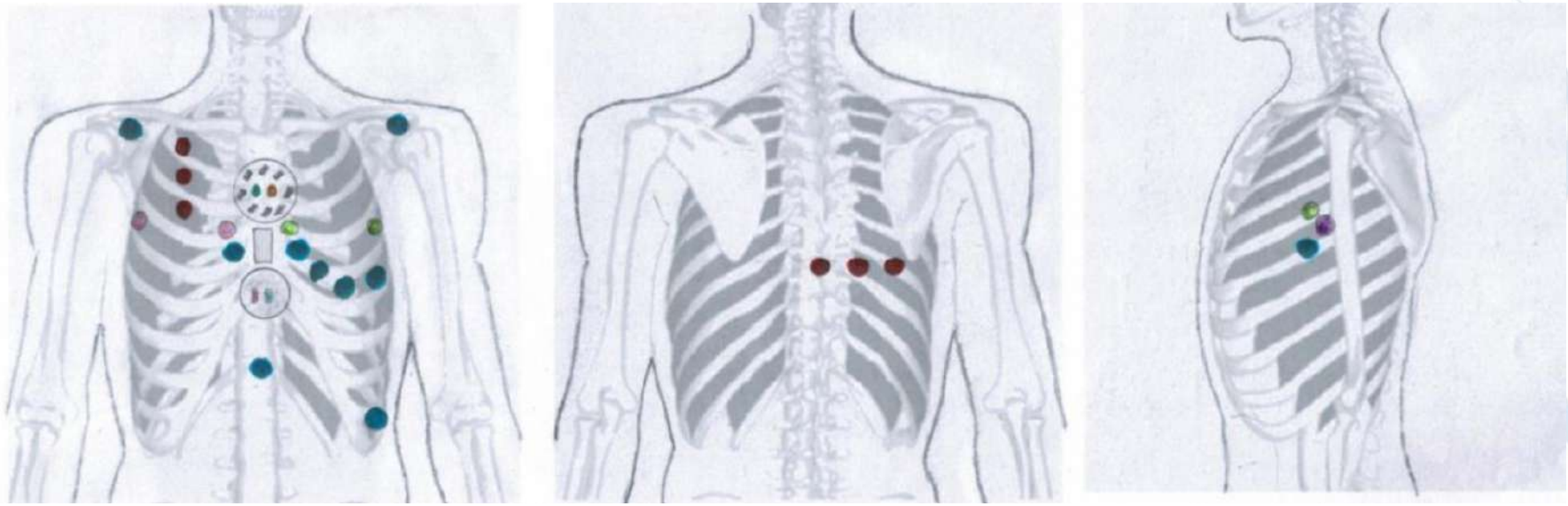
GENICA

- Characterize the demographics of heart failure in Northern Portugal
- Development of a cost-effective algorithm to heart failure approach
- Development of a remote monitoring device
- Development of a drug disposal device to each patient
- Multidisciplinary approach to HF

GENICA

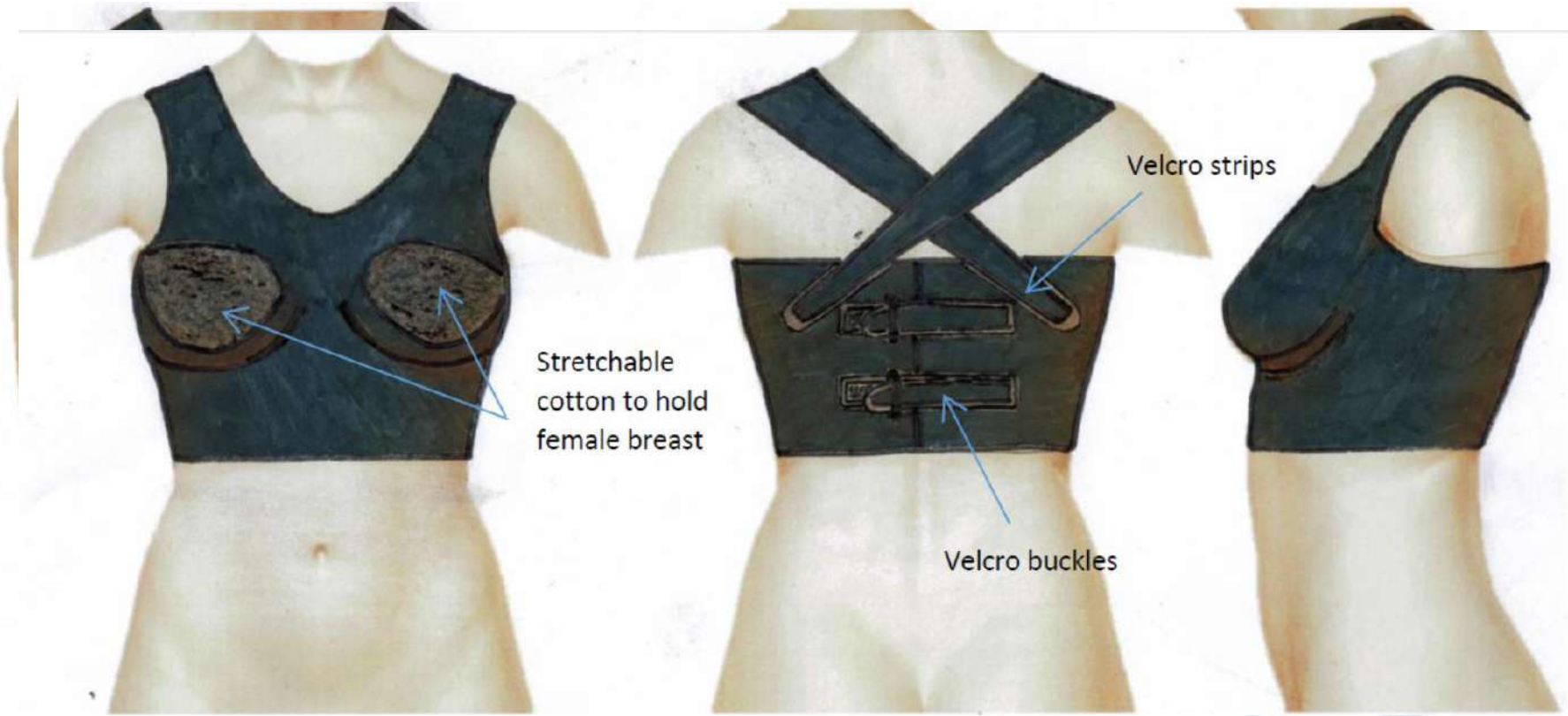
Grupo de Estudos Normalizando a abordagem da Insuficiência Cardíaca em Ambulatório

MONITORIA - sensors



Bioimpedance; ECG electrodes; Sensor assembly for oximetry; PPG sensor; NIRS for RAP; NIRS for LAP; Sodium sensor; Gyroscope / accelerometer.

MONITORIA - vest



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MONITORIA - sensors rationale

Transthoracic impedance – net lung impedance

- Net lung impedance = transthoracic impedance – chest wall impedance
- Net lung impedance ↔ extravascular lung water ↔ all-cause death, cardiovascular deaths and mortality due to heart failure [Impedance-HF trial, Shochat M et al, 2016]

EKG data

- ↓Heart rate variability + elevated heart rate ↔ ↑ mortality and hospitalization [Floras JS, 2009; BEAUTIFUL investigators, Fox K et al, 2008]
- T wave heterogeneity + electrical conduction abnormalities + *de novo* arrythmias ↔ ↑ mortality and hospitalization [Zizek D et al, 2012; Tolppanen et al, 2016]

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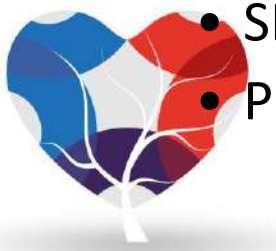
MONITORIA - sensors rationale

Oximetry

- Eight photodiodes + 2 LEDs
- Peripheral desaturation alarm

Photoplethysmography (PPG)

- Impedance cardiography + pulse transit time (pulse wave velocity) = Systemic arterial blood pressure (SBP) + cardiac parameters
- SBP alarm
- Pre-ejection period = therapy monitoring



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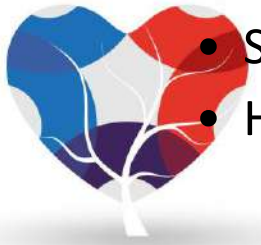
MONITORIA - sensors rationale

Right atrial (RAP) and left atrial pressures (LAP)

- Measured by near-infrared spectroscopy (2 sensors)
- ↑ RAP = ↑ congestion, worse outcome [SICA-HF program, Pellicori P et al, 2017]
- LAP = guide to therapeutic changes, still in research [LAP-Top-HF study, 2016]

Skin sodium content

- Microfluidic patch with chemical transducers
- Still not fully evaluated in HF - MONITORIA pilot-study
- Healthy individuals vs HF individuals



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MONITORIA - sensors rationale

Gyroscope / Accelerometer

- Moderate levels of phyisical activity (PA) = ↓ risk of HF + ↓ all-cause mortality in HF [Rahman I et al, 2015; HF-ACTION, Piña IL et al, 2014]
- Monitoring cardiovascular fitness + PA alarm

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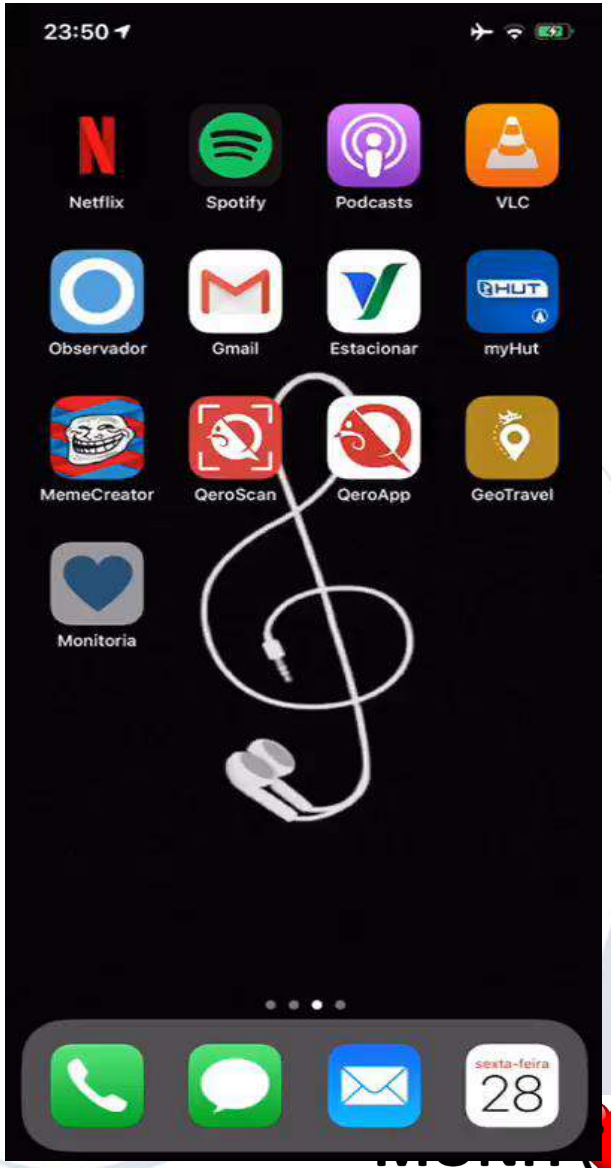
MONITORIA - operating mode



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MONITORIA - alarms

1. New onset of **atrial fibrillation**, atrial fibrillation with rapid ventricular rate, sustained **ventricular tachycardia**, **ventricular fibrillation**;

2. Electric conduction pauses **≥ 2 secs or complete atrioventricular block**. *De novo* right bundle branch block;

3. A **2mm rise in ST segment** at two out of three leads of each group (limb or precordial leads) being highly suspicious of myocardial ischemia;

4. **Heart rate ≤ 40bpm and ≥ 120bpm**, lasting more than 5 min, and no (or minimal) physical activity detected.

5. **Peripheral oxygen saturation ≤89%,** lasting more than 5 min.

6. Instantaneous **lung impedance ≤ 100%**, in three consecutive measurements, or ΔLIR <18%.

7. **Systolic blood pressure ≤ 70mmHg or ≥ 200mmHg**; and/or diastolic blood pressure ≤ 35mmHg or ≥ 100mmHg, lasting at least 5 min.

8. **Right atrial pressure ≥ 8mmHg** in three consecutive measurements.

9. **Left atrial pressure ≥ 12mmHg** in three consecutive measurements.

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MONITORIA - economic analysis

- Target population: severe HF patients (estimated 27000 in 2027) [R. C. Ferreira et al, 2015]
- Price (extrapolated): close to 1000 €; renting price: 50 €/month
- Patient life expectancy after 1st hospitalization = 5 years [D. A. Alter et al, 2012]
- Overall price = 3000 €
- Readmission decrease = about 34% = ↓ 3800 € per patient [D. A. Alter et al, 2012]

- Total net balance: ↓ 800 € in expenditures per patient

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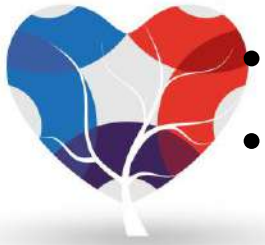
MONITORIA - conclusion

- Non-invasive multi-sensor wearable device
- Huge amount of data collected
- Capable of improving survival and quality of life to its wearer
- Economically viable
- Future-proof:
  - Future options: defibrillator; external pacemaker
  - Minimization
  - AI software to improve early pattern recognition



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