CARDIOCARE:
An integrated platform for the management of elderly multimorbid patients with breast cancer therapy induced cardiac toxicity

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Introduction

- Recent advances in **early cancer detection and therapy** have **dramatically changed** the **natural course of many cancer types** transforming them into chronic diseases.
- However, **long-term collateral adverse effects** caused by **cancer treatment** have emerged as a **major cause of co-morbidity** and **mortality** in cancer patients, which further **impairs their physical, psychosocial status** and **Quality of Life** (QoL) [1].
- With **3 to 4 million cancer patients** diagnosed each year in Europe and with **female Breast Cancer (BC)** being the most frequent cancer (reaching 523,000 new cases in 2018), there is an **increased risk for BC therapy-related complications** [2], such as **cardiotoxicity**.
- This study presents a **beyond the state-of-the-art interdisciplinary platform**, developed in the framework of **CARDIOCARE project** [9], used for the **management of the elderly multimorbid patient with BC therapy induced cardio-toxicity.**
- The innovation of CARDIOCARE relies upon the delivery of a holistic approach for managing BC patients, integrating:
  - **patient-oriented eHealth mobile applications.**
  - **wearable sensors.**
  - **retrospective** and **prospective clinical data.**
  - **advanced data mining** and **machine learning approaches** for the creation of **risk stratification models of cardiotoxicity.**

Methodology

A. Retrospective data

- Retrospective data from **1560 BC patients** have been collected.
- **5 clinical centers:**
  - European Institute of Oncology **(IEO).**
  - Bank of Cyprus Oncology Centre **(BOCOC).**
  - Karolinska University Hospital **(KSBC)**.
  - National and Kapodistrian University of Athens **(NKUA).**
  - University of Ioannina **(UOI)**.
- The data belong to different categories (Cardiac imaging data, Biomarker data, Psycho-markers data, Blood examination data, QoL data, Breast imaging data, Tissue data).

B. Prospective clinical study

- The **CARDIOCARE prospective clinical study** involves **clinical, genomic, biochemical,** and **imaging** (echocardiography, mammography) **procedures, sensor monitoring** of health status and utilization of the **CARDIOCARE mobile application.**
- **750 patients** to be enrolled in a **multi-center clinical study,** in a **12-month recruiting period.**
- The clinical centers involved are:
  - **IEO**: 125 patients.
  - **BOCOC**: 120 patients.
  - **KSBC**: 125 patients.
  - **UOI**: 60 patients.
  - **NKUA**: 195 patients.
  - **IOL**: 125 patients.

C. Sensor Devices

- A smartwatch collects data, such as **daily activity**, **steps**, **heart rate**, **calories**, **sleep hours,** etc.
- A **heart zone sensor** assesses the **patient's cardiac functionality** (electrocardiogram -ECG, Heart Rate Variability -HRV).
- A **hand grip dynamometer** measures **handgrip strength** [3].

D. Omics

- Collection of **genetic biomarkers** relevant to drug metabolism as potential contributions to v**ariations in drug exposure** and subsequent development of cardiotoxicity.
- Several candidate **miRNAs** are also incorporated (eg. miR-29a miR-34a, miR-423, miR-1, miR-122, miR-499, etc.) [4], [5].

E. eHealth mobile application

- CARDIOCARE mobile suite incorporates two sub-applications:
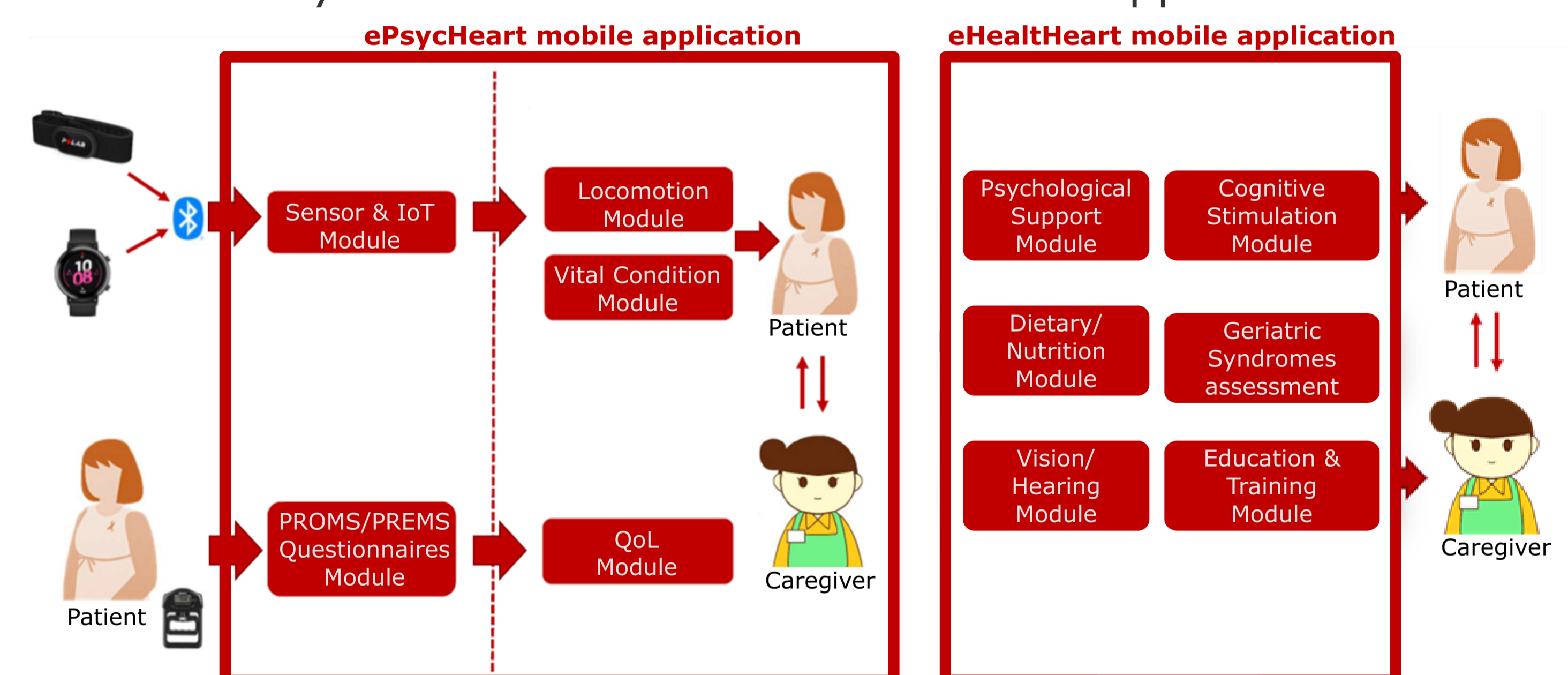 - the ePsycHeart & the eHealtHeart mobile application.

Figure 1: CARDIOCARE ePsycHeart and eHealtHeart mobile applications.

F. Integrated risk stratification model of cardiotoxicity

Risk stratification model of cardiotoxicity from imaging data

- The **image-based risk stratification model** exploits **echocardiography images** to identify new quantitative imaging biomarkers and signatures predictive of cardiotoxicity and patient response.

Risk stratification model of cardiotoxicity from non-imaging data

- The **non-imaging data** include **Electronic Health Records**, l**ab tests**, **circulating biomarkers** and **data coming from the mobile applications.**

G. Infrastructure

- The CARDIOCARE platform is deployed on a **Kubernetes** enabled **cluster** of hardware resources, offering **virtualized** and **containerized monitoring** and **load balancing services**.
- The collected data can then be processed by a **multitude of tools** and **services** to support **visualization**, **cohort creation**, **analytics**, and **knowledge extraction**.

Conclusion

- CARDIOCARE uses **patient-specific data, data from eHealth applications, sensors,** & **machine learning approaches** from **1560 retrospective** and **750 prospective** BC patients in **6 clinical centers' study.**
- CARDIOCARE is an **advanced** and **beyond the state-of-the-art** integrated **platform** for the **management** of elderly multimorbid **patients** with **BC therapy** induced **cardioxicity.**

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