

**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 [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**.
- CARDIOCARE** is an **interdisciplinary platform** used for the **management of the elderly multimorbid patient with BC therapy induced cardio- toxicity**.
- CARDIOCARE innovation relies upon the integration of:
  - 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**

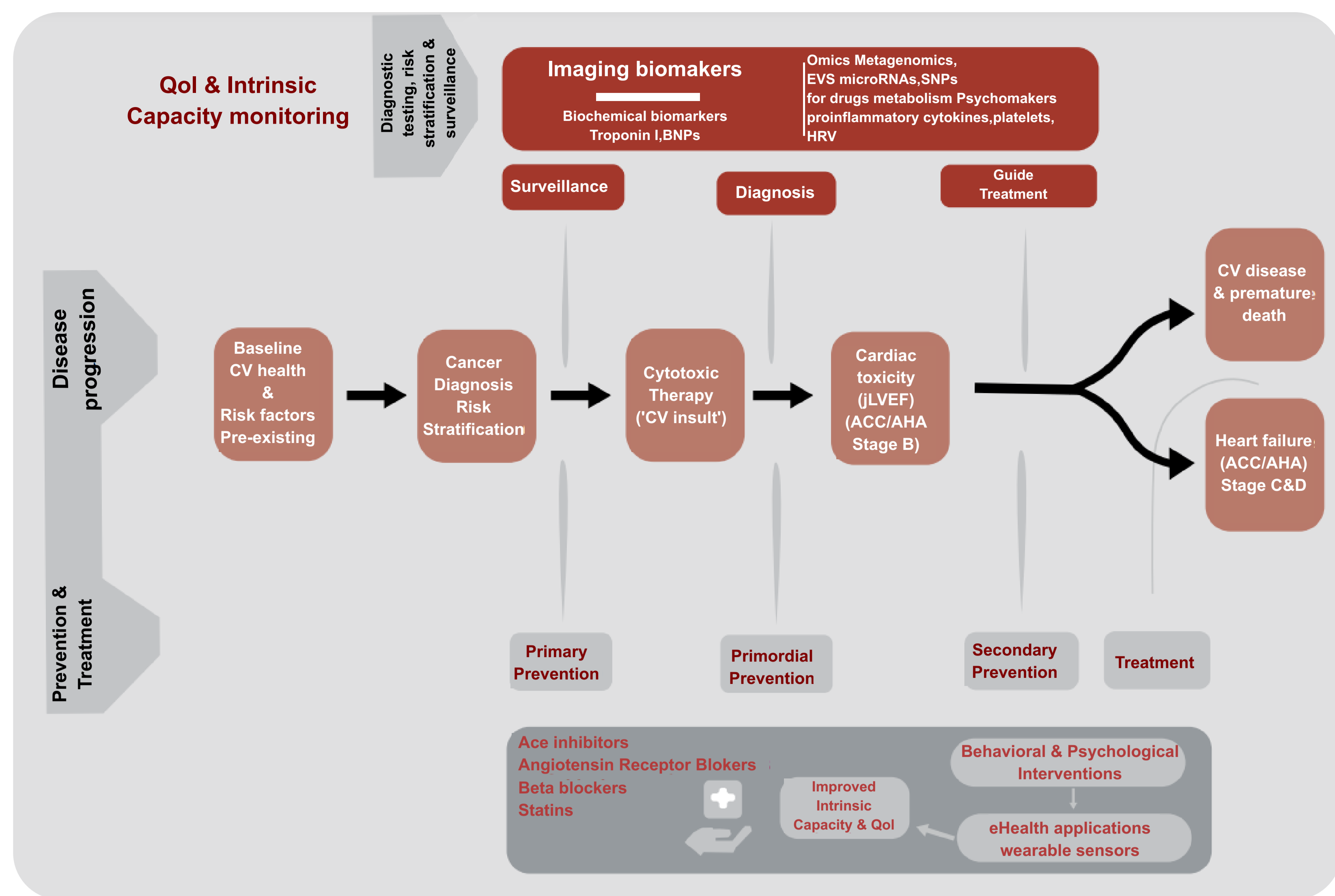


Figure 1: The clinical need addressed by CARDIOCARE.

**Methodology**

**Retrospective & Prospective Clinical Study**

- Retrospective data** from **1587 BC patients** have been collected.
- 5 clinical centers** (retrospective study): European Institute of Oncology (**IEO**), Bank of Cyprus Oncology Centre (**BOCOC**), Karolinska University Hospital (**KSBC**), National and Kapodistrian University of Athens (**NKUA**) and University of Ioannina (**UOI**).
- Retrospective data** belonging to different categories (Cardiac imaging data, Biomarker data, Psycho-markers data, Blood examination data, QoL data, Breast imaging).
- Prospective clinical study** involving **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**.
- 6 Clinical centers** (prospective study):
  - IEO**: 125 patients, **BOCOC**: 120 patients, **KSBC**: 125 patients, **UOI**: 60 patients, **NKUA**: 195 patients and **IOL**: 125 patients.

**CARDIOCARE mobile applications**

- Patients in the **control arm** of the clinical study use the **ePsychHeart mobile application**, while patients in the **intervention arm** use both the **ePsychHeart** and **eHealthHeart mobile applications**.
- The ePsychHeart mobile application is coupled with **wearable sensors**:
  - 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].

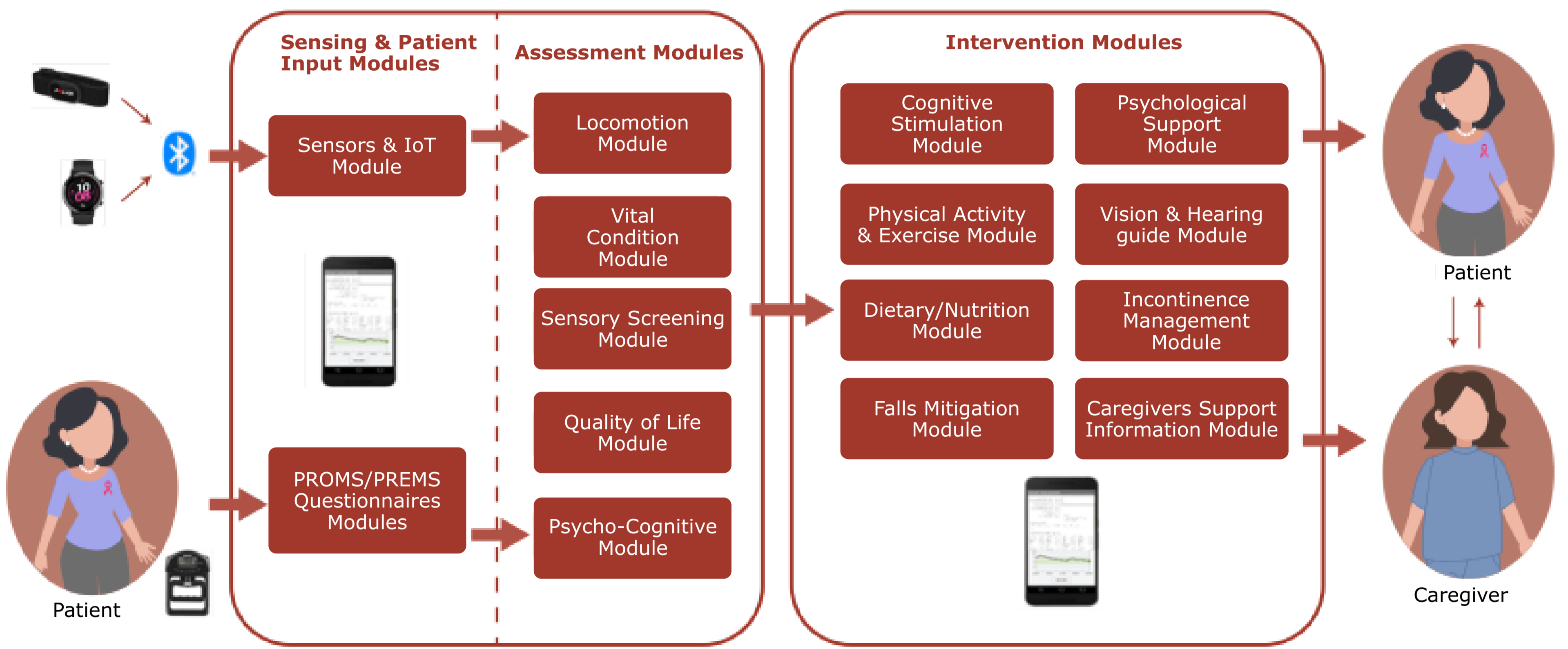


Figure 2: CARDIOCARE mobile applications.

**Integrated risk stratification model of cardiotoxicity**

- The **image-based risk stratification model** exploits **echocardiography images** to identify new quantitative imaging biomarkers and signatures predictive of cardiotoxicity and patient response.
- The non-image risk stratification model exploits data from:
  - Electronic Health Records.**
  - lab tests.**
  - circulating biomarkers.**
  - the mobile applications.**

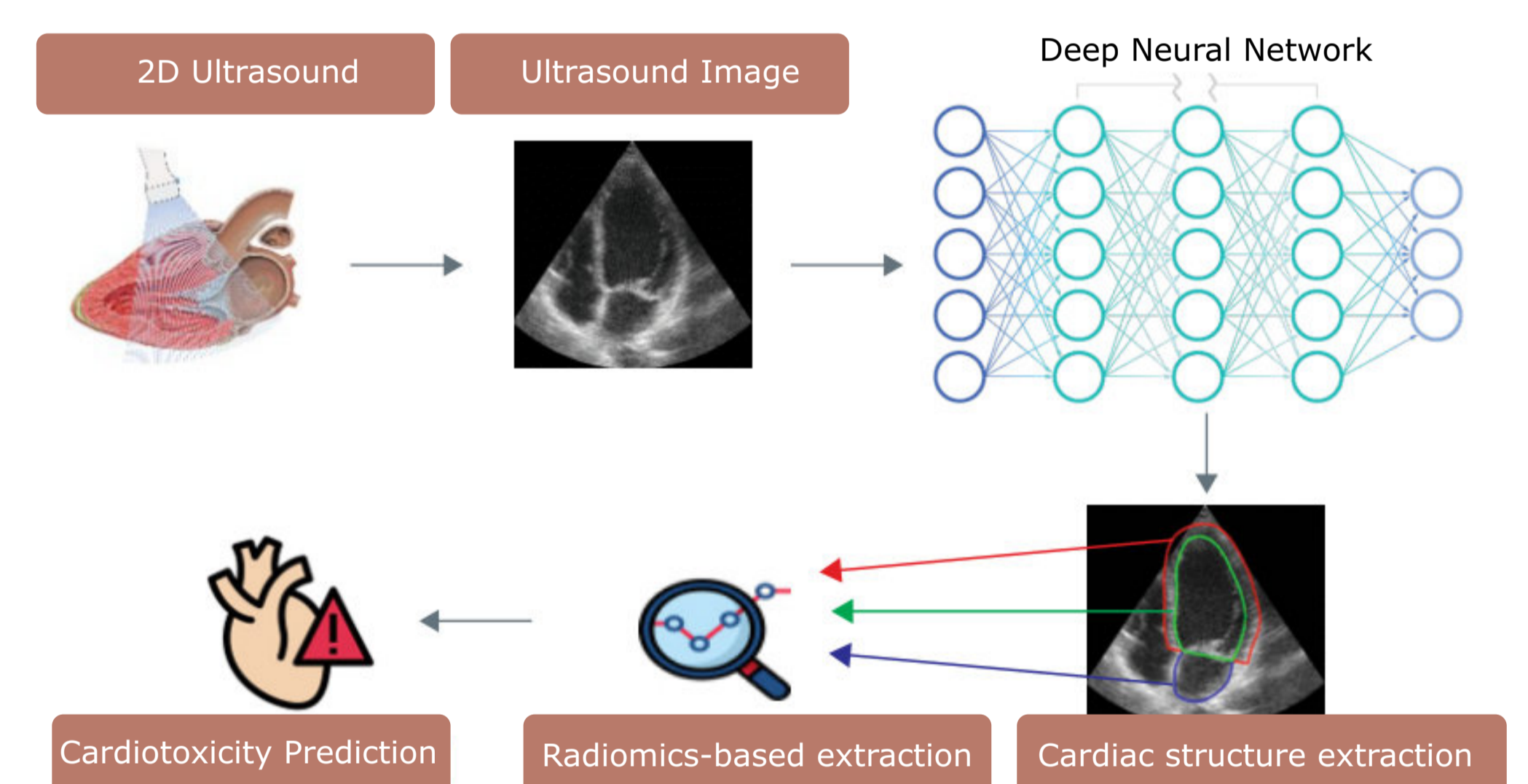


Figure 3: The clinical need addressed by CARDIOCARE.

**Infrastructure**

- The **CARDIOCARE platform** is developed and delivered based on several best-of-breed open-source technologies.
- At its core, the platform can support the **management of the collected data** in ways that make **crosssectional and longitudinal** data integration possible.
- Data is entering the platform through a variety of means, e.g., through batch upload (retrospective data), streams (e.g. sensor data), manual entry, etc.
- Upon entry, data are **harmonized** to a **common data model** with the proper concept **mapping** and **patient identification** & then stored on the platform's specialized repositories.
- The platform itself is deployed on a **Kubernetes** enabled cluster of hardware resources that offers **virtualized and containerized monitoring and load balancing services**.
- The managed data can then be processed by a multitude of tools and services to support **visualization, cohort creation, analytics, and knowledge extraction** through the development of data mining and machine learning models (risk stratification model of cardiotoxicity).

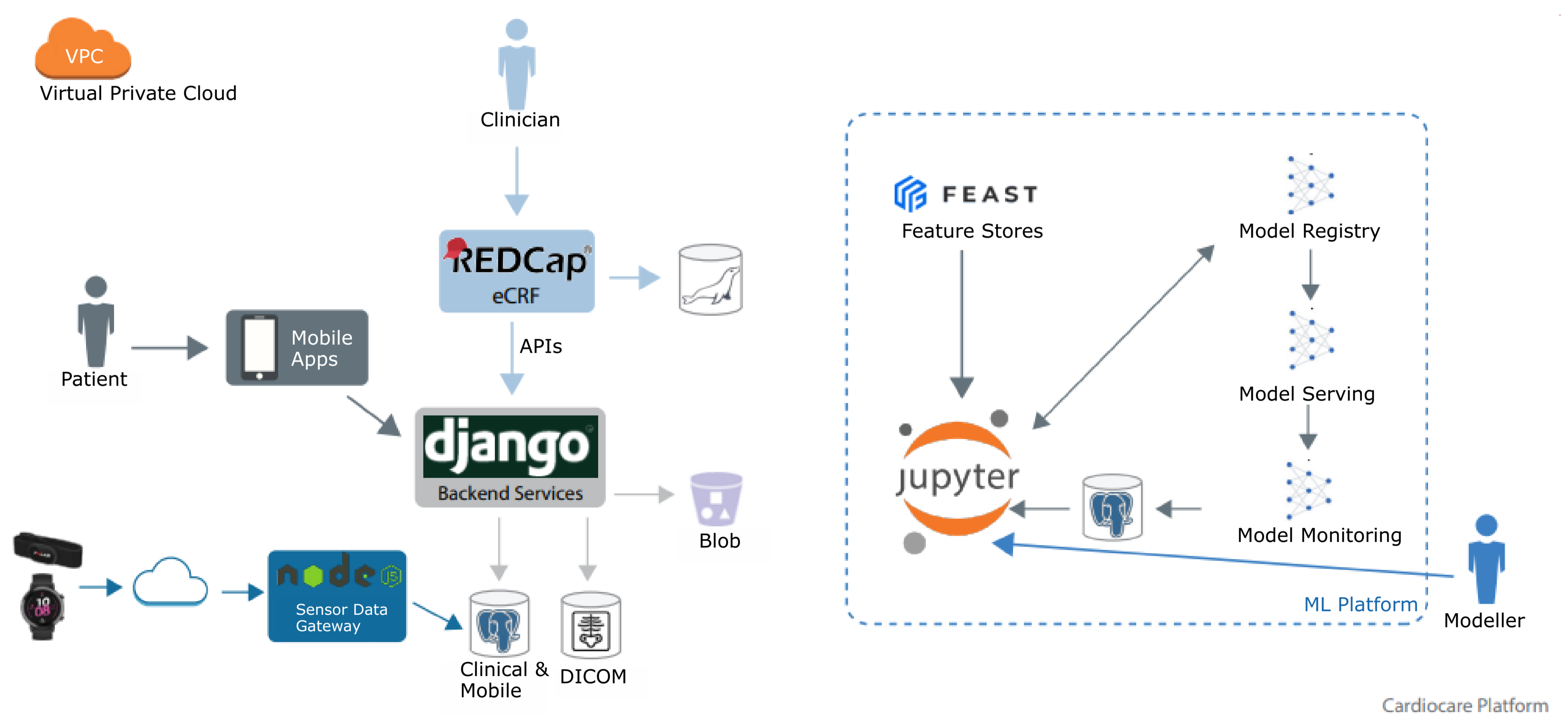


Figure 4: The CARDIOCARE Cloud-based architecture.

**Conclusion**

- CARDIOCARE is an **advanced and beyond the state-of-the-art** integrated **platform** for the **management of elderly multimorbid patients with BC therapy induced cardiotoxicity**.
- CARDIOCARE uses **1587 retrospective** and **750 prospective patient-specific data**, data from **eHealth applications, sensors**, & employs **machine learning approaches** for delivering **advanced risk stratification models of cardiotoxicity**.

**The Consortium**

Social Media

f <https://www.facebook.com/CardioCare.eu>

in <https://www.linkedin.com/company/cardiocare.eu/>

<https://twitter.com/CardioCare.eu>

[1] Y. Koop et al., Eur. J. Cardiovasc. Nurs., doi: 10.1093/eurjcn/zvab057.  
 [2] J. Ferlay et al., Eur. J. Cancer, doi: 10.1016/J.EJCA.2018.07.005.  
 [3] C. Le Zhuang et al., J. Cachexia. Sarcopenia Muscle, doi: 10.1002/JCSM.12614.

