An Open, Ubiquitous and Adaptive Chronic Disease Management Platform for Chronic Obstructive Pulmonary Disease (COPD) and Renal Insufficiency

Project preliminary Overview

Petros Karvelis on behalf of
Dr. Thanos Papadopoulos
Foundation for Research and Technology-Hellas / Biomedical Research Institute, Ioannina, HELLAS

www.chronious.eu
Outline

- Partners
- Background: COPD and Chronic Kidney Disease (CKD)
- New Approach
  - System necessity and objectives
  - CHRONIOUS Vision
- System Design
  - Requirements and system functionality
  - Standalone Instruments
  - Hardware and software architecture
- Implementation
  - System block diagram
  - Components analysis
- Next steps and opportunities
## Partners & major contribution

<table>
<thead>
<tr>
<th>Company</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>TESAN S.p.A.</td>
<td><strong>Coordinator</strong>, Kidney Disease pilot and pathology model provider, call center and ICT infrastructure for interfacing HIS providers</td>
</tr>
<tr>
<td>Azienda Ospedaliero-Universitaria Careggi</td>
<td>COPD and Kidney Disease pilot and pathology model provider</td>
</tr>
<tr>
<td>Universitat de Barcelona</td>
<td>COPD Disease pilot and pathology model provider</td>
</tr>
<tr>
<td>Universität Bremen TZI</td>
<td>Patient Sensing Framework</td>
</tr>
<tr>
<td>Link Consulting, Tecnologias e Sistemas de Informação, S.A.</td>
<td>CHRONIOUS Ontology Framework</td>
</tr>
<tr>
<td>QSC Ltd</td>
<td>Business Leader, CHRONIOUS Monitoring Framework</td>
</tr>
<tr>
<td>SESA Gmbh</td>
<td>CHRONIOUS Ontology Framework, CHRONIOUS Guideline Framework</td>
</tr>
<tr>
<td>Pomurje Incubator Networks Ltd</td>
<td>CHRONIOUS Guideline Framework</td>
</tr>
<tr>
<td>DAP Noesis Business Solutions Ltd</td>
<td>CHRONIOUS Monitoring Framework</td>
</tr>
<tr>
<td>PLANET</td>
<td>CHRONIOUS Monitoring Framework</td>
</tr>
<tr>
<td>C.E.R.E.T.E.TH.</td>
<td>CHRONIOUS Wearable</td>
</tr>
<tr>
<td>Uniscan Instruments Limited</td>
<td>Patient Sensing Framework</td>
</tr>
<tr>
<td>Fraunhofer-Gesellschaft zur</td>
<td>Patient Sensing Framework</td>
</tr>
<tr>
<td>CURE – Center for Usability Research &amp; Engineering</td>
<td>CHRONIOUS Monitoring Framework</td>
</tr>
<tr>
<td>Solianis Monitoring AG</td>
<td>Patient Sensing Framework</td>
</tr>
<tr>
<td>MICRODATA Advanced Technology SA</td>
<td>CHRONIOS Monitoring Framework</td>
</tr>
<tr>
<td>MIP-Consorzio per L’innovazione</td>
<td>CHRONIOUS Guideline Framework</td>
</tr>
<tr>
<td>IXTENT s.r.o.</td>
<td>Dissemination Leader, CHRONIOUS Ontology Framework</td>
</tr>
<tr>
<td>Foundation for Research and Technology – Greece</td>
<td><strong>Technical Manager</strong>, CHRONIOUS Monitoring Framework</td>
</tr>
</tbody>
</table>
In 1990, a study by the World Bank and WHO ranked COPD 12th as a burden of disease; by 2020, it is estimated that COPD will be ranked 5th.
Background: COPD

- COPD is the 4th leading cause of death in the USA and Europe.

- In people aged 25–75 yrs in the USA, the estimated prevalence of mild COPD was 6.9% and of moderate COPD was 6.6%.

- Passive smoking carries serious risks, especially for children and those chronically exposed. The WHO estimates that passive smoking is associated with a 10-43% increase in risk of COPD in adults.

\(^1\) National Health and Nutrition Examination Survey – NHANES.
Chronic kidney disease (CKD)

- is an **important condition** affecting around 10% of the population,
- is an **important cause** of cardiovascular complications.
CHRONIOUS necessity

Necessities

- **Economy:** Chronic diseases have a significant negative impact on health and economies.

- **Patient:** significant effects on physical, motional and mental well-being condition.

■ **Present status:** Limited interest for programs for the prevention of chronic diseases.
Objectives

- Defines a European framework for a generic health status monitoring platform, addressing people at risk or with chronic health conditions.

- Provides the guidelines and standards of the future generations of “chronic disease management systems”.

- Develops services that exploit the mass amount of data recording
  - monitoring,
  - patient-system interaction,
  - acute episodes,
  - health history,
  - hospitalisation data.
An advanced multi-parametric expert system that fuses information effectively from various sources using intelligent techniques.

Fields of application:
- Chronic Obstructive Pulmonary Disease (COPD)
- Chronic Kidney Disease (CKD) and Renal Insufficiency.
CHRONIOUS Vision

- CHRONIOUS achieves to monitor all patients suffering from chronic diseases without interfering in their everyday life.

- The platform is patient-centric with main modules integrated in PDA.

- The result will be the integration of a platform unique for each patient and capable of detecting real-time a severe situation (critical and not) with high accuracy.
Need for Continuous Patient Monitoring

- COPD cannot be cured, but long term monitoring and severe situation handling, allow decreasing the rate of progression of chronic respiratory failure.

- Chronic Kidney Disease and Renal Insufficiency, with appropriate medical management can be limited or even prevented in some instances.

  - 74% of patients believe that with proper treatment, it is possible to live a full and active life.
  - 76% of physicians say that the long-term health outlook for chronic disease has improved in the past decade.
Approach for Individualized Diagnosis

- Communicative wearable health systems are recognized as one of the most promising platforms for minimal obtrusive and individualized health services at the point of need.

- The system adapts to patient’s needs, metabolism, habits, demographic and ethical data.
Platform Requirements

- **Information Acquisition**
  - Local wearable sensors
    - Electrocardiogram (ECG), Electromyogram (EMG), respiration, skin temperature, Pulse rate, oxygen saturation (SpO₂)
    - Activity sensors
    - Air quality, presence of smoke, increased air particles, abnormal sounds
  - Remote sensors
    - Blood pressure, weight scale
  - User interfaces
    - Food and drug intake, biochemical parameters, demographic data

- **Sensor Interfaces**
  - Local wearable sensors
    - analog, serial, USB, infrared, etc.
  - Remote sensors
    - 802.11, Bluetooth.
Standalone Instruments I

- Three-leads Einthoven triangle ECG signal acquisition
- Several processing algorithms embedded

Applications will be:

- Cardiovascular risk patient monitoring
- Pulmonary disease patient monitoring
Standalone Instruments II

- **Respiratory rate measurement**

System properties:
- Integrated in T-Shirt
- Dual signal acquisition (thorax and abdomen)
Noninvasive arterial oxygen saturation measurement

Heart rate measurement

System properties:
- Finger clip is the most reliable sensor
Standalone Instruments IV

- **Acceleration sensor (3 axes)**
  - Standard SMD implementation: SMB380 of Bosch Sensortec GmbH

- **Ambient temperature and humidity**
  - SMD device of Sensirion AG

- **Skin Temperature**
  - SMD device of IST AG

- **Sweat/Moisture Sensor**
  - Shirt integration questionable at the moment
CHRONIOUS platform has six major components interacting each other as follows:

- Sensors
- Infrastructure
- Data Handler Component
- Smart Assistant Device
- Home Patient Monitor
- Clinician
- CHRONIOUS Central System
The sensors are divided into four categories:
- Medical sensing system
- Motion sensing system
- Environmental sensing system
- Social-context monitoring which combines the measurements from Heart Rate Sensor, Microphone, Respiration Rate
Sensors Framework

- Collects various vital and other signs and transmits them to data Handler through the Communication Module.

- A vest has been chosen for the integration of most wearable sensors into it. The vest communicates with the data Handler through wires.

- The rest of the sensors are using Bluetooth technology to transmit data.
Data Handler Component

- Data Handler is a small portable device, which can be attached easily in the same case with PDA.

- Has inputs only from sensors and outputs to Smart Assistant Device. Also, in some particular cases feedback can be given to sensors in order to retrieve new pack of data (in case the previous ones were corrupted).

- Data acquired by sensors are wirelessly or by cable (in case of sensors integrated to the vest) transmitted to Data Handler component.
Home Patient Monitor

- An important infrastructure for patients who cannot use PDA technology easily. PDA has a small screen, tiny buttons and its GUI is more appropriate for a young adult.
- Home Patient Monitor will offer a more user-friendly interface for inputting data and reading alarms and advices.
Smart Assistance Device

PDA (that will be used) contains five major elements:

- Feature Extraction
- Graphical User Interface
- Intelligence Core
- Severity Estimation
- PDA Repository
Smart Assistance Device

- **Has inputs from:**
  - Data Handler
  - Central System
  - Home Patient Monitor

- **Outputs of PDA feed:**
  - Health Professional (severe situation)
  - Central System (monitored and raw data for training and storing)
This Component is a central server located in a hospital and can communicate with PDA and Clinician’s computer. It’s **main scopes** are:

- To contain all required modules for creating and training of patient profile model.
- Updates PDA Database with more recent data and vice versa.
The “Clinician Framework” is considered a healthcare professional’s computer or a medical team which is responsible for a specific patient’s health.

Clinicians have access to the system in order:
- To add Guidelines in the Repository.
- To receive alarm messages in case of a severe situation.
Innovations in Guidelines generation

CHRONIUS
- Contains all the decision support functionality wrapped in a back-office component.
- Responsible for providing the possible diagnosis and treatments according to the medical category of the patient and the patient specific data available.
Next steps

- User requirements analysis and functional system specification are being deployed.

- The overall detailed architecture of CHRONIOUS platform is being considered.

- The business framework will be constructed in order to develop a commercial system.
Thank you!

Questions please mail
Dr. Thanos Papadopoulos
(thpapado@cc.uoi.gr)