WP2 - CO-DESIGN OF INTEGRATED CARE

D2.2: ADAPTIVE CASE MANAGEMENT DESIGN

H2020-EU.3.1: Personalised Connected Care for Complex Chronic Patients

Project No. 689802

Start date of project: 01-04-2016

Duration: 42 months

Revision: 1.4

Date: 31/07/2017

Document Information

Project Number	689802	Acronym	CONNECARE
Full title	Personalised Connected Care for Complex Chronic Patients		
Project URL	**http://www.CONNECARE.eu**		
Project officer	Hubert Schier		

Deliverable	Number	2.2	Title	Adaptive Case Management Design
Work Package	Number	2	Title	Co-design of Integrated Care

Date of delivery	Contractual	MONTH 16	Actual	MONTH 16
Nature	Prototype ☐ Report ☑ Dissemination ☐ Other ☐			
Dissemination Level	Public ☑ Consortium ☐			

Responsible Author	Isaac Cano	Email	iscano@clinic.ub.es
Partner	IDIBAPS	Phone	+34 93 227 5747

Abstract	From an Adaptive Case Management (ACM) perspective, patient-centred case management is defined as a set of well-standardized tasks to be carried out with a patient on the basis of his/her health condition and social circumstances to achieve target objectives, aligned with his/her comprehensive treatment plan. Therefore, an ACM platform should provide the technological infrastructure for case management that conventional systems cannot support because patient-centred case management processes are too dynamic and involve collaborative work among healthcare professionals managing new cases reusing previous structured experiences.
	The main aim of this document is to provide a comprehensive description of the organisational and technological dimensions of ACM in healthcare that have been taken into account in the co-design of the functional requirements of the CONNECARE smart ACM platform. In addition, existing site-specific organisational and technological settings within which CONNECARE case studies and technologies will be implemented, are described.
	Ultimately, this document will be input to the co-design process and the functional specifications of CONNECARE integrated care services and supporting adaptive case management technologies.

Table of contents

Executive Summary

Adaptive case management (ACM) is being promoted as a new paradigm to support flexibility for healthcare professionals during the continuously evolving process of patient-centred care. Cases vary so much that case managers are constantly striving for innovative approaches to meet the needs of new cases. Therefore, case managers are involved not only in picking a predefined action from a set of well-standardized tasks to be carried out to a patient in alignment with his/her comprehensive treatment plan, but also in helping to improve the actions that can be taken during the process of case management by sharing and discussing with other healthcare professionals. If this process of continuous refinement of patient-centred case management processes can be done by case managers themselves, then a case management system can be considered to be adaptive.

Patient-centred case management processes, as stated above, need to be flexible as planned treatment processes varies for each individual patient. The clinical process execution depends on the health state of the patient and therefore, needs to be adopted dynamically by medical doctors and nurses. Thus, deviations from planned treatment processes are frequent. From a technical point of view, to support such required flexibility at the clinical process level, the core process engine of any ACM system should consider the Case Management Model and Notation specification [1] as the reference framework.

The main goal of this document (**Section 1**) is to provide a comprehensive description of the organisational and technological dimensions required to effectively support deployment of the Smart Adaptive Case Management (SACM) platform of CONNECARE. The adjective "Smart" here refers to the Clinical Decision Support System embedded in the CONNECARE SACM platform, which is meant to both (i) provide guidance to practitioners in assessing risk stratification of patients and design of each individual personalised clinical pathway accordingly – through machine learning –, and (ii) refine the ongoing organisational and clinical processes themselves – through process mining.

These dimensions have been considered during the co-design process of CONNECARE case studies to generate the complete set of functional specifications (reported in Section 4 of deliverable *D2.4: CASE STUDIES DESCRIPTION AND THE ASSOCIATED CO-DESIGN*) of the CONNECARE SACM platform, which will be developed as part of CONNECARE work package 3 activities. Complementary to this document, deliverable *D2.4: CASE STUDIES DESCRIPTION AND THE ASSOCIATED CO-DESIGN* also reports other aspects of the CONNECARE ACM design (i.e., CONNECARE case study definitions, associated workflows and an initial design of the graphical user interfaces for professionals and patients), as results of the CONNECARE co-design process. Moreover, deliverable *D2.3: PATIENT-BASED HEALTH RISK ASSESSMENT AND STRATIFICATION* complements this document with the description of CONNECARE decision support strategies to optimize patient-based health risk assessment and service selection in order to facilitate design of individualized care plans.

Finally, **Section 2** describes existing site-specific organizational and technological settings that will ultimately converge with project-specific ACM outcomes to effectively support CONNECARE case studies.

1. Adaptive Case Management in healthcare

Over the last years, the epidemics of non-communicable diseases and the need for cost-containment are triggering factors for a profound reshaping of the way we approach delivery of care for chronic patients [2]. Integrated care, following the Chronic Care model, is widely accepted [3]. In the new scenario, conventional disease-oriented approaches, centred on the management of clinical episodes, are being replaced by novel patient-centred case management services, which requires cooperation among healthcare providers, across healthcare tiers, and with social support. Such a transition has proven successful in areas wherein one organization is providing care [4–6], but extensive deployment of case management services in settings with heterogeneous healthcare providers is still a challenge.

The two major barriers for adoption of patient-centred case management [7] are: *i)* Organisational interoperability among professional teams, from different providers and healthcare tiers, working around the patient; and, *ii)* Technological interoperability among heterogeneous healthcare information systems.

Organisational interoperability - In order to overcome current organisational barriers, health and social care systems need to develop an approach that better co-ordinates and integrates services around the needs of patients and service users of all ages with chronic, medically complex and disabling conditions. This is where the potential of Adaptive Case Management (ACM) for planning, coordinating and reviewing the care of an individual is greatest, as extensively described in **Section 1.1** below. From an ACM perspective, patient-centred case management is defined as a set of well-standardized tasks to be carried out with patients on the basis of their health condition and social circumstances to achieve target objectives, aligned with their comprehensive treatment plan. ACM provides the infrastructure for knowledge-based work (e.g. case management) that conventional systems cannot support because processes are too dynamic, variable and unstructured. The overarching goal of the ACM approach is to enable the case manager to face new cases reusing structured experiences with previous cases without needing any special skills. Over time, the case manager should be able to adapt the system to his or her own style of working without needing the help of any specialist.

Technological interoperability - Information and communication technologies (ICT) have a major role in facilitating organisational interoperability among heterogeneous providers, each one using proprietary health information systems. Moreover, the use of appropriate ICT has been shown to be essential to support continuity of care through collaborative tools, facilitating accessibility of citizens and patients to healthcare and generating a disruptive scenario in terms of information management. We acknowledge that examples of successfully addressing the technological requirements associated with the deployment of case management services within a given health information network do exist [8, 9]. However, this issue remains a major challenge in those healthcare sectors with heterogeneous providers each one using proprietary hospital information systems and with a luck of operational strategies for health information sharing. To overcome this challenge, CONNECARE consider the adoption of workflow

orchestration engines [8] (i.e., the CONNECARE smart ACM platform) to facilitate the flow of information, tasks and events among participants of a case management processes. Very recently, the Object Management Group (OMG) released its Case Management Model and Notation (CMMN v1.1) specification [1], which defines a common model and notation for modelling and graphically expressing ACM, as well as an interchange format for exchanging Case models among different tools, as described in detail in **Section 1.2**.

Ultimately, the above key organisational and technological aspects for adoption of patient-centred case management, taking into account CONNECARE site-specific case studies, has been considered as basis for co-design of the set of general functional requirements (reported in Section 4 of deliverable *D2.4: CASE STUDIES DESCRIPTION AND THE ASSOCIATED CO-DESIGN*) for the actual development of the CONNECARE Adaptive Case Management platform in work package 3.

Finally, **Section 2** describes existing organizational and technological settings in each site (i.e., Barcelona (Spain), Lleida (Spain), Groningen (The Netherlands) and Assuta (Israel)) within which CONNECARE case studies and technologies will be implemented. Evaluation strategies and co-design activities carried out during the project lifetime will allow to document of advances in the site-specific organizational and technological outcomes.

1.1   Coordinating and integrating patient-centred services with an ACM perspective

Although case management, as a practice (and even profession), is adopted in many goal-oriented, data-driven and decision-centric areas (e.g., licensing and permitting in Government, application and claim processing in Insurance, and mortgage processing in banking), the following definition originated in the Healthcare industry and has become a de facto definition (without Healthcare-specific terminology): "*Case management is a collaborative process of assessment, planning, facilitation and advocacy for options and services to meet an individual's and family's comprehensive health needs through communication and available resources to promote quality cost-effective outcomes*" [9].

This definition suggests the following:

– **Central to the process is the "case" itself**. In Healthcare: the "individual's health", with all related needs, and the additional information throughout its life cycle.

– **The case worker is the person in charge of a case** (advanced practice nurse acting as case manager in most healthcare providers), whose skills allow him or her the freedom to make decisions, for which (s)he is responsible.

– **Case management is collaborative and communicative.** Case workers will have to respond to internal and external events. In healthcare, case management is the result of a joint activity between the case workers and patients/carers.

– **When events occur, it is often not predetermined which activities have to be executed and in what sequence.** The case worker has to assess needs first, after which further action has to be planned accordingly.

– **The goal to be reached is clearer than the path to follow.** There might be a variety of options to reach the goal, and the case worker's decisions will gradually determine the path. Processes will evolve rather than being predefined.

Rather than being a single intervention, case management refers to a package of care which focuses on a specific condition or group of conditions, but most often is generic and aimed at individuals with complex needs. In some contexts it can refer to an ongoing programme of individualised care aimed at keeping people with long-term conditions well, but in others it refers to an intensive, personalised and time-limited intervention aimed at preventing a specific occurrence or event – usually an emergency hospital admission.

Cases vary so much that case managers are constantly striving for innovative approaches to meet the needs of new cases. Therefore, case managers are potentially involved not only in the case, and picking a predefined action, but also in helping improving the actions that can be taken during the process of case management by sharing and discussing with others. If this process of continuous refinement of case management processes can be done by knowledge workers (i.e., case managers) themselves, with no need of traditional programming skills, then a case management system can be considered to be adaptive.

The CONNECARE Adaptive Case Management approach for coordinating and integrating patient-centred processes, as previously defined in deliverable *D2.1: COOK-BOOK FOR PROJECT DEVELOPMENT*, is composed of the following stages: i) **case identification** (i.e., case-finding); ii) **case evaluation** (i.e., assessment), iii) **work plan definition** (i.e., care planning); iv) **follow-up and event handling** (i.e., care coordination); and, v) **program discharge** (i.e., case closure in time-limited interventions) or exitus. Each of these stages typically involves the participation of a limited number of actors and are planned on an anticipatory basis. Therefore, if they are properly designed, each of them should render outcomes that are relevant for execution of the next phase [10]. This might suggest that case management is a linear process with sequential elements. However, in practice, most individuals will undergo repeated monitoring and review as well as further assessment and care planning until they are fit for discharge. Below, we re-examine the importance of each component of the CONNECARE ACM processes.

Briefly, **case identification** refers to the patient's information required at the entry point to determine his/her eligibility for a given programme. The information considered in this stage is typically selected based on criteria of easy access, management and its high sensitivity value to identify candidate patients.

Case evaluation includes assessment of the patient to capture the information required for patient risk stratification and service selection. Dimensions that may be covered in an individual's assessment include, but are not limited to:

- clinical background and current health status
- current level of morbidity
- current ability and needs in terms of activities of daily living
- current level of cognitive functioning
- current formal care arrangements
- current informal care arrangements
- social history
- physical care needs
- medication review
- social care needs
- wider needs, including housing, welfare, employment and education

Ultimately, the package of care offered in a case management programme will depend on the results of the individual's assessment process. Specifically, the **individualized work plan definition** will consist on a set of both timed and non-timed tasks, led by a team of healthcare professionals, a care giver or the patient itself, aligned with the aims of the programme.

> The **main purpose of the work plan** is to support the case manager in providing a structure to the individual's care and to ensure that the goals of all the different services are aligned with each other. It is used as a reference tool to map the different types of service or input required, and their frequency.

A fundamental component of the successful functioning of a team of healthcare professionals is the presence of an individual (a case manager) who works in coordination with a team of professionals to organise and deliver a person's care: making referrals to various services, coordinating all the different services he/she should liaise with, ensure that referrals have been picked up and acted on, monitor whether the individual has made any progress, etc. This involves continual communication with patients, their carers, and the various professionals and services they come into contact with during work plan follow-up and event handling.

The **Follow-up and event handling** component of case management programs considers the individualized work plan as a 'live' document that changes depending on the individual's condition and how much progress has been made. Therefore, although this component can often be described as a next stage in the process of case management, it should be perceived as an ongoing process that structures and facilitates the effective delivery of care over time. The most common activities undertaken by case managers and their teams during follow-up and event handling are:

- **Medication management** - Case managers spend a substantial proportion of their time ensuring that the individual's medication regimen is appropriate and up to date, that they are adhering to it, and are not experiencing any adverse side effects. To do this, they must communicate with the individual patient, general practice staff, specialists, the out-of-hours service and sometimes community pharmacists.

- **Self-care support** - Whatever the level of care offered to a patient, for most of the time they have to manage their own conditions (sometimes with the help of their carer). Supporting self-care can consist of many activities, such as: providing (and/or making referrals for) general health education and advice (e.g., smoking cessation, diet, exercise, etc.), and coaching about the most appropriate service to contact regarding non-urgent questions related to health or during an exacerbation.

- **Advocacy and negotiation** - One of the case manager's key roles is advocating for and negotiating on behalf of the individual so that they have access to the services and equipment identified in their care plan. The case manager can also negotiate directly with service providers where patients and carers cannot do this for themselves. As a result, the case manager may be able to negotiate a prompt response to referrals or speed up the process of obtaining medication, equipment or home care services

- **Psychological support** - Psychological support might best be described as part of the general process of building a therapeutic relationship between care-giver and patient. It is a key strategy in supporting self-care, in identifying and supporting an individual's willingness to change behaviour, or facilitating changes in the future goals for their care.

- **Monitoring and review** - The monitoring process allows work/care plans to be constantly reviewed and changed where necessary. Depending on the individual's level of need, monitoring can take place daily, weekly or monthly, and directly, in the individual's home, and/or through remote monitoring (for example, by telephone or through a telehealth device that measures blood pressure or other vital signs).

Finally, the case is prepared for his/her **discharge** from the programme. Where case management programs are intended as time-limited interventions aimed at avoiding crisis, it is essential that there is a clear process for discharge, which helps to manage the long-term capacity of case management programs and ensures that those patients with the greatest need are able to access the correct support at the most appropriate time.

1.2 Current standards to support Adaptive Case Management

Compared to processes in industry, typically modelled using the business process modelling and notation (BPMN)[11], clinical processes, as described above, need to be more flexible as a treatment process

varies for each individual patient. Flexibility is required by the fact that the clinical process execution depends on the health state of the patient and therefore, needs to be adopted dynamically by medical doctors and nurses. Thus, deviations from planned treatment processes are frequent.
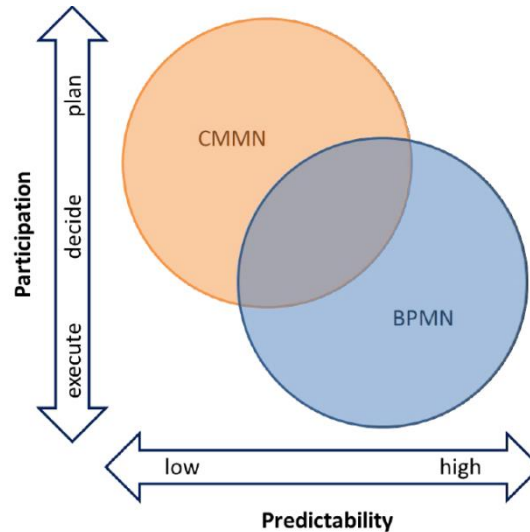

Figure 1 – Areas covered by BPMN and CMMN. BPMN is used for predictable and well-structured processes with a little complex work and therefore minimal participation by case managers. This is in direct contrast to the characterization of CMMN, which is designed for unpredictable and flexible processes. Data is central and tasks have to be executed and can be planned by case managers.

To this end, adaptive case management (ACM) is being promoted [12–14] as a new paradigm to support flexibility for healthcare professionals during the continuously evolving process of case management, for which the Case Management Model and Notation (CMMN v1.1) specification [1] is the reference modelling framework (see **Figure 1**).

The current version 1.1 of the Case Management Model and Notation (CMMN) [15] was created by the Object Management Group (OMG) and published in December 2016 (www.omg.org/spec/CMMN/1.1/). It is a complementary notation to BPMN[11]. We will say that CMMN is declarative in which you describe "what" is allowed and disallowed in the process; versus BPMN that is imperative in which you describe "how" to do the process. BPMN, CMMN, and the Decision Model and Notation (DMN) are the three OMG business modelling notations.

The case is the main concept in CMMN, and it is similar to a process. A case contains a **case file** (i.e. case data container) and it is described by a **case plan**, which may eventually be executed. The CMMN specification distinguishes between the planning and execution of a case plan, as illustrated in **Figure 2**.
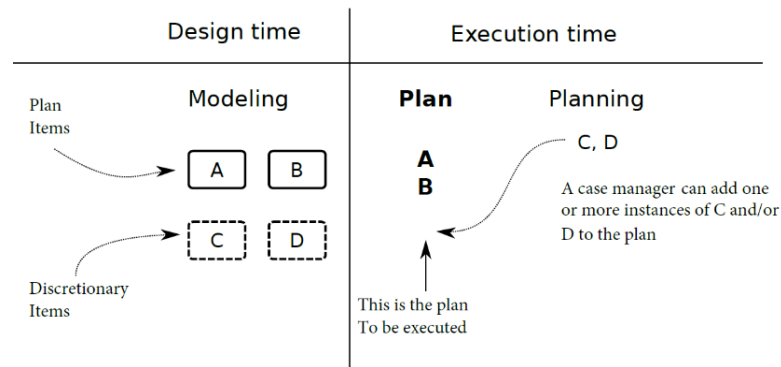
Figure 2 - *At design time, case managers models both plan and discretionary items (e.g., tasks, stages, milestones, etc.). At execution time, only planned items are in the execution plan. However, case managers can add to the execution plan the discretionary items they consider necessary for the particular case instance.*

Tasks are central elements in CMMN to define a single actions that needs to be performed. In addition to the ordinary Task, there are 5 different types of task-elements in CMMN:

- **The Non-Blocking Human Task:** this task does not stop the process flow. This means that in the case model, it is done at the same moment it started and the process flow continues unobstructed. All other tasks are by default 'blocking'.

- **The Blocking Human Task:** this task stops the process flow until it is completed.

- **The Process Task:** this task is used to invoke a defined process (e.g., BPMN process) and passes parameters to this process. This allows organizations to reuse processes.

- **The Decision Task:** this task links to a Decision Model and Notation (DMN) diagram (http://www.omg.org/spec/DMN/Current). DMN is a standard approach for describing and modelling repeatable decisions within organizations to ensure that decision models are interchangeable across organizations.

- **The Case Task:** this task is used to invoke a new CMMN case that has its own context and also passes parameters to this newly activated case. This allows organizations to reuse cases.

Each Task can be depicted as an ordinary Task or as a **Discretionary Task**, which is non-obligatory but may be performed at the case worker's (i.e., case manager's) own discretion.

Figure 3 – Visual CMMN elements

Completion of a set of tasks or the availability of key deliverables, typically leads to reaching a **milestone.** Milestones are achievable targets which enable evaluation of case progress. Dependencies between plan and discretionary items (e.g., tasks, stages, milestones, etc.) are modelled using sentries. A **sentry** "watches out" for **events** (e.g., timer event, user event, etc.) to occur and/or a condition to be true so that the corresponding task or stage is enabled/completed or a milestone is achieved.

In CONNECARE, the CMMN v1.1 specification is also the reference modelling framework to support Adaptive Case Management processes. The Meta-Model of the smart ACM system, which will be reported in detail as part of work package 3 deliverable *D3.1. DARWIN platform for healthcare,* contains most of the CMMN elements previously described. However, full coverage of CMMN elements is not envisioned within the project lifespan.

2. Existing organisational and technological settings to support adaptive case management in all sites

This section summarises existing site-specific (i.e., Barcelona (Spain), Lleida (Spain), Groningen (The Netherlands) and Assuta (Israel)) organizational and technological settings, which evolution will be assessed at the end of the project as part of the CONNECARE evaluation strategies to assess the degree of adoption of CONNECARE collaborative care processes and supporting adaptive case management technologies in all sites.

2.1 Barcelona (Spain)

In 2010-13, the strategic plan of the Hospital Clínic of Barcelona introduced a strategy for "Digitalization of Clinical Processes". Multiple committees [8,16] have been working to reengineer key processes (e.g., electronic prescription, patient portals) and areas (e.g., intensive care, emergency room, surgery, etc.) of the hospital, with an integrated vision within the Barcelona-Esquerra healthcare district and, most importantly, around the needs of the patients.

To this end, health information exchange systems have been developed as part of the interoperability framework of Barcelona-Esquerra healthcare district [16] and the regional tools for interoperability at healthcare level (i.e., the Catalan IS3 program[1]). Although there is agreement at conceptual level on the need for technological support for an effective deployment of novel collaborative and integrated care processes, current tools are not enough to fully support adaptive case management. CONNECARE technologies will enable the consolidation of such adaptive case management technologies to support, firstly, CONNECARE case studies 2&3 (Peri-surgical care and promotion of physical activity) and ultimately, CONNECARE case study 1 (Management of Complex Chronic Patients), as indicated in the Protocol for regional implementation of community-based collaborative management of complex chronic patients [17].

2.1.1 Existing organizational setting

2.1.1.1 The Integrated Health Area of "Barcelona-Esquerra"

Since mid-2000s, the South-Eastern healthcare district of Barcelona city, which encompasses 540,000 inhabitants, also known as Ais-Be (Area for Integrated Health in Barcelona-Esquerra), has deployed, and continuously developed, integrated care services for chronic patients [16,18]. Integration of health and

---

[1] http://www.ticsalut.cat/projectes/is3/es_index/

social services in Ais-Be is carried out under the umbrella of the regional health plans [19] every five years.

The Barcelona-Esquerra healthcare district includes the Hospital Clinic de Barcelona as reference centre, 2 general hospitals and 19 primary care centres run by different healthcare providers. A public body, Consorci Sanitari de Barcelona, representing the unique regional payer, runs by Ais-Be. However, Hospital Clinic de Barcelona is the main driver as a "dual hospital": a teaching, high-tech and research focused hospital (for the entire population of the Ais-Be and in some cases as a national reference centre) and as a community hospital (for 300,000 inhabitants).

Primary Care
· Institut Català de la Salut: 13 teams
· CAPSE: 3 teams
· EAP Poble Sec: 1 team
· EAP Sarrià-Vallplasa: 2 teams
Specialty Care
· Hospital Clínic
· Hospital Plató
· Hospital Sant Joan de Déu
· Hospital Sagrat Cor
Mental Health and Addictions
· Hospital Clínic
· Hospital Sant Joan de Déu SSM
· Hospital Sant Pere Claver
· Associació Centre Higiene Mental Les Corts
· Agència Salut Pública de Barcelona
Social Health Care
· Parc Sanitari Pere Virgili
· Centre BlauClínic
· Clínica Sant Antoni de Barcelona
· Fundació Sociosanitària Barcelona
· 33 Community Pharmacies
· 4 Rehabilitation Centres
· Emergency Services (*Servei d'Emergències Mèdiques de Catalunya* – SEM)

Table 1 - *Main healthcare suppliers in the integrated health care area of Barcelona Esquerra (Ais-Be).*

Within Ais-Be a wide range of health service suppliers coexist: public and private, primary care, specialized care and social health care, as shown in **Table 1**.

Before 2006, all of these suppliers worked in isolation, and the creation of Ais-Be was aimed at the integration and coordination of all the services and professionals working in the area. Thus, an organisational development and re-engineering process was defined around the integration of care pathways and the fostering of the relationship between the different suppliers and their professionals. The framework of "dual hospital" was clear for the managerial structure but an iterative strategy was mandatory to progressively involve all front line clinicians.

The resulting collaborative model is closer to a professional network than a hierarchical organisation [16]: it has no legal existence, no single management, and no model of financing for the territory, tools that are in theory more robust for developing integrated care. Results obtained by Ais-Be have been reached,

therefore, with tools like clinical management, strategic planning and analysis of patient-centred processes, which have facilitated to break down barriers between entities and levels of care.

2.1.2 Existing technological setting

2.1.2.1 Interoperability framework of "Barcelona-Esquerra"

A platform has been implemented at the Information Systems level for interoperability and communication between suppliers, based on sending messages whose information is integrated in the suppliers' differing information systems (**Figure 4**), with the following features:

- Reports of hospital admissions, emergencies and outside consultations of the Hospital that can be viewed immediately from Primary Care

- Appointment requests from Primary Care (GP or specialist) at the Hospital, with appointment and confirmation of the activity performed

- Request for image test and receipt of the image and of the report of results

- Telecare projects (e.g. teledermatology)

In addition, Ais-Be has an intranet (www.ais-bcn.cat) to facilitate the collaborative work of the professionals in the territory, and its contents are the outcome of the work of the Operational Committees. The part of the information that is general to Ais-Be and the materials oriented to patients and the public have no restrictions on access.

On top of Ais-Be interoperability framework, the regional (Catalan) interoperability framework, which has been extensively described before in deliverables *D5.1 COLLABORATIVE DIGITAL HEALTH FRAMEWORK* (Section 4.1.1) and *D7.1 EVALUATION PLAN FOR THE ENTIRE PROJECT* (Section 6.4), is a key component of the plans for developments in the BCN site.
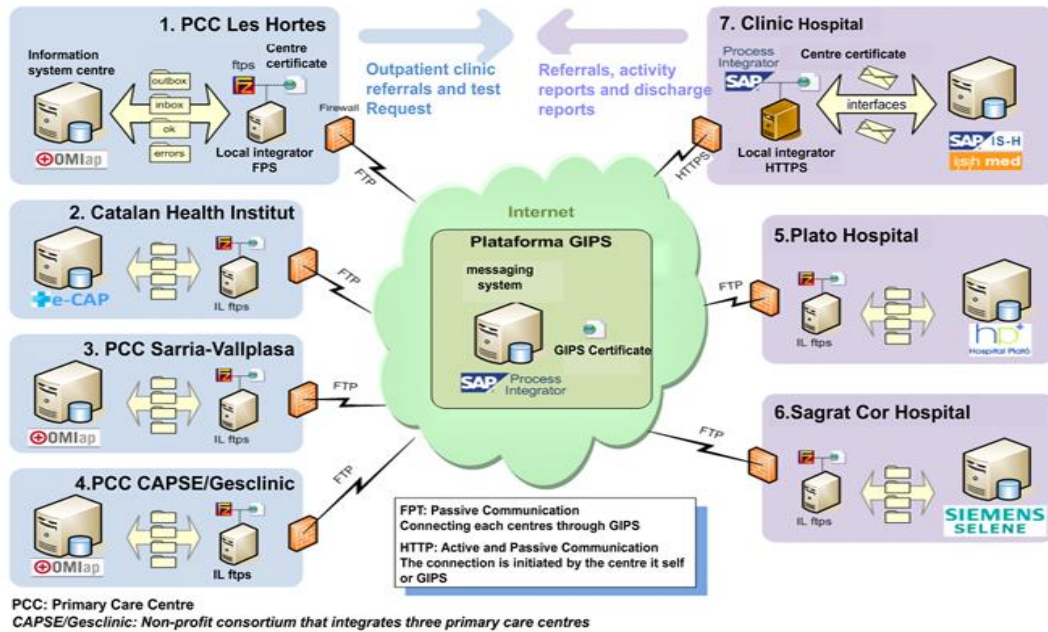
Figure 4 - Interoperability platform and communication between the Information Systems of the suppliers of the Ais-Be.

2.1.2.2 Strategies for innovation of Clinical Processes at Hospital Clínic of Barcelona

In order to facilitate convergence of the previously described interoperability and communication strategies at Information Systems level of "Barcelona-Esquerra" and the Catalan region, the 2010-13 strategic plan of the Hospital Clínic of Barcelona introduced a strategy for "Digitalization of Clinical Processes". From an organizational/functional point of view, this required reengineering key processes (e.g., electronic prescription, patient portals) and areas (e.g., intensive care, emergency room, surgery, etc.) of the hospital with an integrated vision around the needs of the patients. At a technical level, this resulted in the use of SAP NetWeaver Process Integration (SAP PI) to integrate the various applications that support clinical processes at Hospital Clínic of Barcelona, and in the development of novel graphical user interfaces on top of the existing hospital information systems (i.e., with a service oriented architecture based on information and communication standards).

Since the creation of Ais-Be was aimed at the integration and coordination of all the services and professionals working in the area of Hospital Clínic of Barcelona, the above strategy clearly supports the organisational development and re-engineering of process towards the integration of care pathways that foster the relationship between the different suppliers, professionals and patients. However, in order to reinforce the scalability of the above strategy, a process engine becomes a key component of the

interoperability framework to support collaborative care processes among different areas and levels of care.

2.1.3   Peri-surgical care as immediate case study to foster local developments

Peri-surgical care (i.e., CONNECARE Case Studies 2 and 3) has become a key service within Barcelona plans for developments of Adaptive Case Management at local and regional level within the project lifetime. To this end, the following main group of activities are considered of importance relevance, as described in detail in **ANNEX I**:

- Broader environments and methodologies (i.e., design thinking) for co-design of services among healthcare professionals, managers, patients and experts in service design. To this end, a series of three design thinking workshops will be held during September/October 2017. This workshops will be organized as an inter-cluster activity between the Catalonia Health Technology cluster and the Barcelona Design Innovation cluster.

- Interplay among CONNECARE technological tools and complementary experiences with commercially available case management process engines (e.g., Camunda[2], Cúram[3], etc.). Ultimately, site-specific activities in this respect during 2017 should contribute to gain deeper experience and consolidate adaptive case management solutions for scalability of the peri-surgical care program at regional level during 2018.

2.2   Lleida (Spain)

Overall, integrated care strategies in the Health Area of Lleida, are creating a collaboration network that is fully aligned with the CONNECARE project aims and vision, and the CONNECARE project, given its relevance and magnitude, is being the catalyst allowing to go one step beyond and involve an increasing number of professionals of different disciplines.

Although regional tools for interoperability at healthcare level (i.e., the Catalan IS3 program[4]) are in place, site-specific tools and systems are still disease-driven and thus limited. There's a clear lack of a unified interoperability framework that could centralize all ongoing and to-be-developed processes supporting adaptive case management and/or full communication between suppliers.

---

[2] https://camunda.org/

[3] https://www.ibm.com/watson/health/government/social-program-management/

[4] http://www.ticsalut.cat/projectes/is3/es_index/

2.2.1 Existing organizational setting

2.2.1.1 The Health Area of Lleida

The Health Area of Lleida provides assistance to more than 350.000 people spread over 5,447 km^2 in a rural area in the in the west of Catalonia (**Figure 5**). The whole region is structured around 2 hospitals, Hospital Universitari Arnau de Vilanova and Hospital Universitari de Santa Maria, both of them located in the city of Lleida, and a network of 23 Primary care centres covering the whole territory and dividing it into Basic Health Areas (ABS).
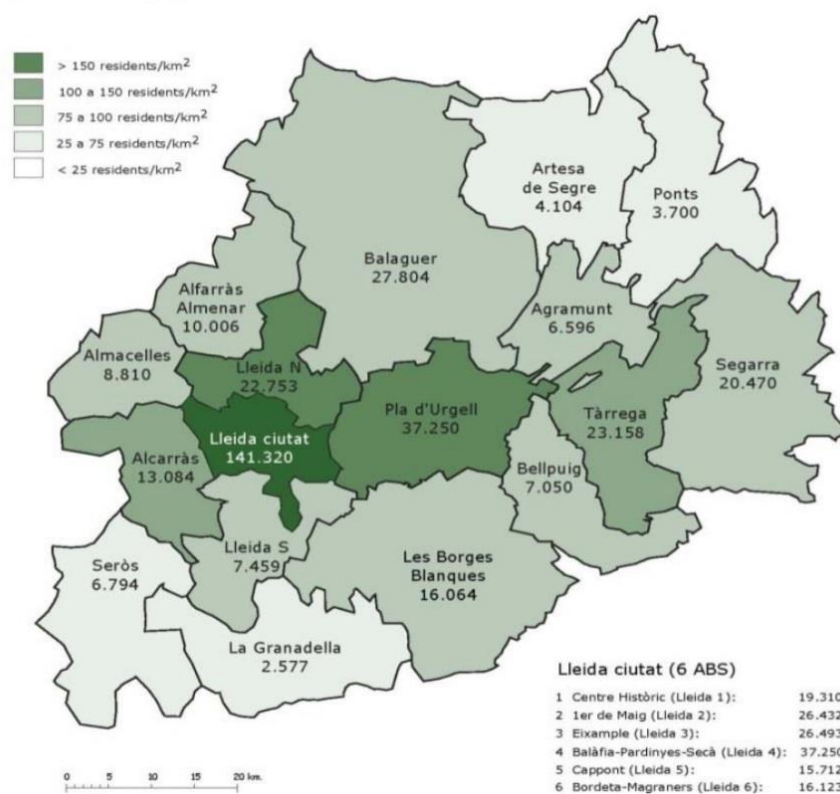

Figure 5 - *Population and population density of the Health Area of Lleida in 2016 by Basic Health Areas (ABS), corresponding to the population and territory covered by a single Primary care centre.*

A wide range of health service suppliers coexist in the Health Area of Lleida: public and private, Primary care, specialized care and social health care. However, several processes are being implemented to foster the relationship between the different suppliers and their professionals and optimize care pathways. Two types of integrated care initiatives are being implemented: (i) programs aiming to increase the communication and promote synergies between health care professionals at different levels; and, (ii) programs aiming to enhance the communication between patients and physicians by means of telemonitoring tools.

An outstanding example is the integrated care program for respiratory diseases, which involves family physicians of each ABS and the personnel of the Respiratory department at Hospital Universitari Arnau de Vilanova, with the main goal of increasing the capacity of Primary care centres to adequately manage chronic respiratory patients, Family physicians receive advanced training from the Specialized Care personnel. This training increases their expertise but also forges a close bond with the Hospital personnel. Additionally, communication channels at three levels (real face to face, virtual, and text) have been established, thus reducing the need of referring patients from Primary care centres to the Hospital. Overall this program is very successful in areas like Chronic Obstructive Pulmonary disease (COPD) or Obstructive Sleep Apnoea (OSA) [20], and has brought high level specialized respiratory medicine to the geographic area were patients live, taking advantage of the close relationship that exist between patients and programs like the advanced telemonitoring system for ambulatory control of patients with hypertension is also a good example of integrated care. , This program has an interface enabling professionals to review the blood pressure measures that the patients send using their smart-phone or computer. Another example isr the MyOSA project, which provides real-time compliance with Continuous Positive Airway Pressure (CPAP) treatment of OSA patients. Both programs include reinforcement messages and educational videos that are received automatically by patients, as well as a short message system that patients can use to query their physicians about specific issues. This kind of programs are also being very successful [21].

2.2.2 Existing technological setting

The baseline technological setting in Lleida fully relies on the regional (Catalan) interoperability framework, which has been extensively described before in deliverables *D5.1 COLLABORATIVE DIGITAL HEALTH FRAMEWORK* (Section 4.1.1) and *D7.1 EVALUATION PLAN FOR THE ENTIRE PROJECT* (Section 6.4). Regardless of the success of several project-specific tools and systems that have been implemented to foster interoperability and communication between suppliers in very specific areas (as described in previous section 3.2.1), none of the initiatives have been yet escalated to the whole Health Area of Lleida and/or to a broader range of diseases/pathologies. The main barrier for full escalation is the lack of a unified interoperability framework that could centralize processes and support adaptive case management. In this sense, CONNECARE offers a great opportunity to tackle this structural need.

2.3 Groningen (The Netherlands)

The University Medical Centre Groningen (UMCG), composed of a reference medical centre in Groningen and 13 community hospitals spread out over the provinces of Groningen, Friesland en Drenthe, plays an active role in providing integrated care in Northern Netherlands. In addition, UMCG has a close (also legal) collaboration with hospitals in the Eastern part of the province of Groningen. Typically, the more complex patients are referred to the UMCG for treatment and are subsequently discharged to hospitals,

general practitioners offices, nursing homes, rehabilitation centres and/or social services in the region where the patient resides.

Currently, UMCG doctors have access to a physician portal enabling them to see medical information from the UMCG used by all primary and secondary care doctors in the community. However, automated electronic connections to primary or community care have not yet been established, meaning that several electronic records of a patient exist throughout the healthcare system. To improve on this situation, a regional IT infrastructure for the exchange of medical data is being adopted.

2.3.1 Existing organizational setting

The healthcare system in the Netherlands has a social insurance background with dominant roles for not-for-profit sickness funds, independent providers and a modest role for the government (http://www.euro.who.int). The general practitioner has a gatekeeping position as care provider and point of referral to other services and institutions. The healthcare system has a tradition of social health insurance covering about two-thirds of the population with lower incomes. For the other one-third a private health insurance scheme applied. In 2006 a major healthcare reform was carried out leading to a unified compulsory insurance scheme. Since then the roles of actors in the healthcare system has changed drastically. For example, multiple private health insurers now had to compete, in a regulated environment, for insured persons, and relatively independent bodies, rather than the government became largely responsible for the management of the system. Social support was delegated to the municipalities. The organizational structure of healthcare is depicted in **Figure 6**.

The University Medical Centre Groningen (UMCG) is a teaching and research centre in the Northern Netherlands. With 1,300 beds, UMCG admits nearly 37,000 patients and hosts over 500,000 outpatient visits annually, and employs 11,000 people. The multidisciplinary research on healthy ageing extends from fundamental biological and (pre)clinical research through to applied research into social effects of disease and health, such as the cohort study LifeLines. Typically the region Northern Netherlands deals with a relatively high prevalence of age-related chronic diseases (**Figure 7**). Together with the relatively low socio-economic status of citizens the region serves as an ideal test bed for the development and implementation of innovations supporting active and healthy ageing. This has been recently recognized by awarding Northern Netherlands four stars as a European reference site in the field of Active and Healthy Ageing.
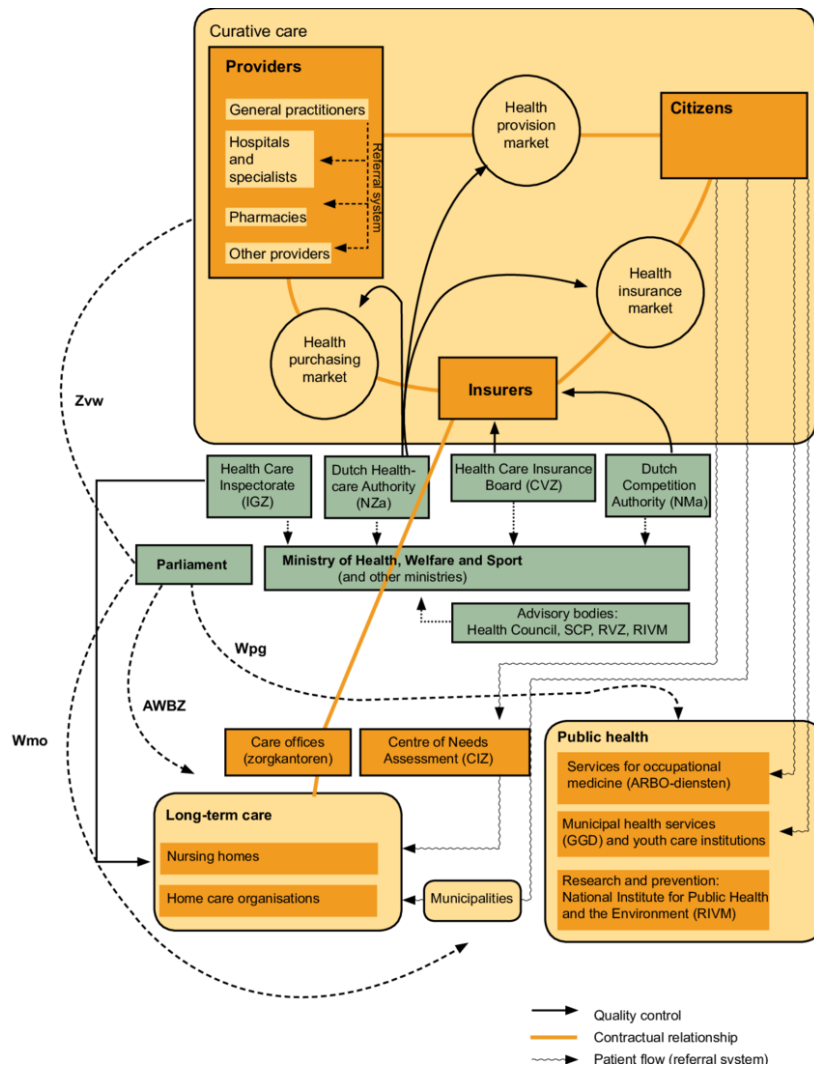
Figure 6 - Overview of the Dutch healthcare system (extracted from[5]).

[5] http://www.tarsc.org/publications/documents/TARSC%20RWJF%20Netherlands%20case%20study%20final.pdf
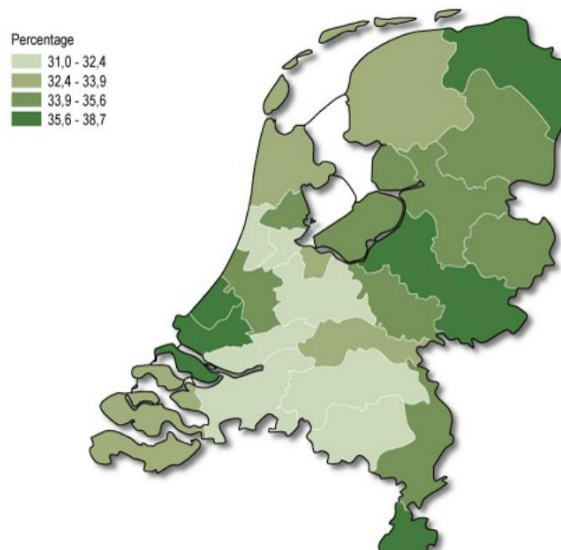
Figure 7 - Prevalence of age-related chronic diseases in the Netherlands.

The UMCG plays an active role in providing integrated care in Northern Netherlands. Being the only academic tertiary hospital in Northern Netherlands the UMCG has a catchment area extending far beyond the city of Groningen. The Northern Netherlands has 1.7 million inhabitants, with 14 hospitals providing care for patients. These 14 hospitals consists of one university medical centre (in Groningen) and 13 community hospitals spread out over the provinces of Groningen, Friesland en Drenthe. Specifically, the UMCG collaborates with all community hospitals, but has a close (also legal) collaboration with hospitals in the Eastern part of the province of Groningen. Typically, the more complex patients are referred to the UMCG for treatment and are subsequently discharged to hospitals in the region where the patient resides. As such, integrated care is delivered by communicating hospital and discharge plans between hospitals, general practitioners offices, nursing homes, rehabilitation centres and social services.

2.3.2 Existing technological setting

The UMCG network has a comprehensive regional coverage of healthcare programs regarding personalised health programs. The ICT system supports all of its administrative and clinical functions including a computerised electronic medical record that includes every aspect of the patient's clinical care beginning prior to admission and continuing with post discharge follow up. UMCG doctors have access to physician portal enabling them to see medical information from the UMCG used by all primary and secondary care doctors in the community. However, automated electronic connections to primary or community care have not yet been established, meaning that several electronic records of a patient exist throughout the healthcare system.

To improve on this situation, at the end of 2011 all hospitals in Northern Netherlands have expressed their wish to achieve a regional IT infrastructure for the exchange of medical data by setting up a IHE-Cross-Enterprise Document Sharing (XDS) infrastructure (**Figure 8**).
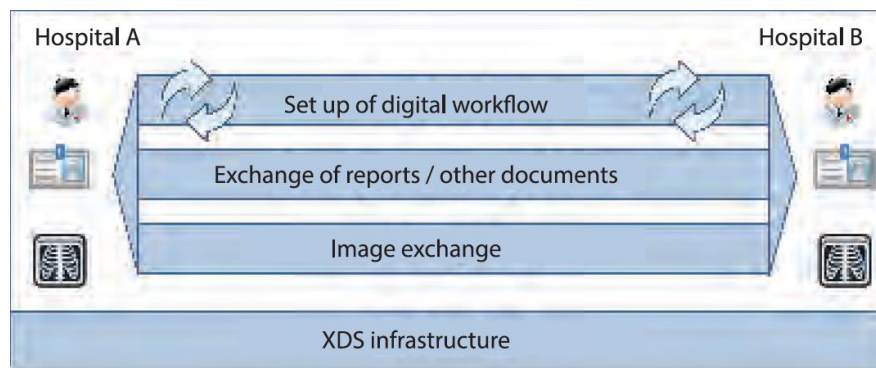

Figure 8 - Regional IT infrastructure for the exchange of medical data.

At the start of the project there were already three existing XDS infrastructures in the region. These were used for delivering cardiology and echo studies in Medical Center Leeuwarden (MCL) and Groningen (UMCG and Martini hospital Groningen) and for making conducted nuclear studies from the MCL available to nearby community hospitals. The goal was to set up one centrally housed XDS infrastructure for the region. XDS was deployed not only for the exchange of images, but also for the exchange of reports and requests. In doing so the system supports healthcare professionals in their daily work. From 2015-2016 all hospitals in Northern Netherlands have started using the IHE-XDS standard for the exchange of medical information.

From January 2018 the current hospital information system will not be support by the supplier. This has led to an accelerated implementation of a new Electronic Patient Dossier (EPD) which will be operational December 2017. To ensure that the EPD can be implemented successfully adaptations to the current ICT infrastructure will be made. The focus on implementing the EPD poses many challenges for the UMCG as organization resulting in an ICT-freeze for all not necessary IT projects. For CONNECARE this means that a step-wise approach will be followed to allow connection of different external IT systems to the EPD of the hospital. In first instance the necessary medical information of patients will be entered manually in the SMS and SACM systems. Following the start of the clinical studies at the end of 2017 we will gradually progress into making automated IT connections with third parties allowing full integration of all medical information into the CONNECARE system.

2.4   Assuta (Israel)

Assuta Medical Centre, the largest private hospital system in Israel. Is a subsidiary organization of Maccabi Healthcare Service, the second largest Health Plan in Israel with 2 million members nation- wide (25% of the total Israeli population). Maccabi, which has operated a central Electronic Medical record

since the mid 90's, has been a leader in integrated care in Israel. In 2012 Maccabi began to operate the Maccabi Multidisciplinary Telemedicine Centre (MOMA) for integrated care and care management of patients suffering from chronic disease, using an adaptive case management approach supported by the EMR and computerized protocols. In 2015, Maccabi implemented of the Compass Continuity of Care Program for integrated transitional care of patients hospitalized and discharged back to the Community that also uses a case management approach, The most recent and a most ambitious system for integrated care is being led by Assuta n the city of Ashdod, where a new acute care hospital built and operated by Assuta, is the hub of an integrated care system joining community healthcare services operated by the Health plans and Social Services operated but the Ashdod Municipality. Adaptive case management is the cornerstone of the integrated care processes that are currently being implemented by Assuta and Maccabi in Ashdod, building upon and extending the experience garnered in the MOMA and Compass Programs.

The CONNECARE technological tools (i.e., the SACM and the SMS – self management app), together with the existing digital systems in Assuta and Maccabi, will contribute to the development and consolidation of an adaptive case management system that will be replicable and scalable throughout Israel and ultimately, will inform healthcare systems outside of Israel.

2.4.1 Existing organizational setting

2.4.1.1 The Israeli Health Care System

The Israeli health care system is a national universal and compulsory health insurance system in which 4 nationwide, competing Health Plans are responsible for covering and providing comprehensive healthcare services for their members (in accordance with the public basket of services as defined in the law and updated annually). The Health Plans are obligated to assure that their members receive timely, accessible and high quality healthcare services in accordance with their needs. Because the Health Plans are both insurer and provider, and they also have to live within a given budget, they are. de facto, expected to manage the care of their members. Since 1995, all of the Health Plans have been computerized and have implemented Electronic Medical Records.

2.4.1.2 Multidisciplinary Chronic Disease Management Centre (MOMA)

In 2012 Maccabi, using the above infrastructure, embarked upon a program for integrated care and care management for patients suffering from chronic disease and opened its Multidisciplinary Telemedicine Centre (MOMA). This is a 24/7 Care management System in which every patient is assigned a nurse case manager responsible for proactively managing and integrating his/her care in coordination with the patient's primary care physician. The nurse case manager is supported by a multidisciplinary team including: specialist physicians, a social worker, a clinical pharmacist and a physical therapist. She has

full access to the patient's EMR and in addition has a care management system with computerized protocols that provide her with alerts and reminders regarding all of her patients. Patients receive tablets used primarily for video conferencing. The nurse proactively contacts the patient in accordance with the patient's condition and her protocols and the patient or his carer/family member can contact the Centre at any time of the day or night 7 days a week. The Centre cares for about 7000 patients at any given time and since opening has cared for more than 20,000 patients.
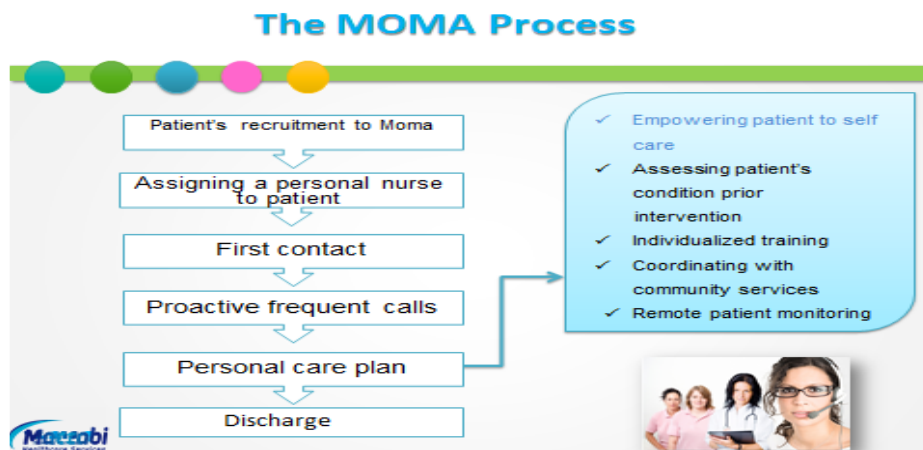

Figure 9 - The Patient Care Process in the Multidisciplinary Telemedicine Centre.

2.4.1.3 Continuity of Care Program

In 2015, Maccabi took its next step in integrated care and implemented the Compass Continuity of Care Program (**Figure 10**) that provides integrated transitional care for every patient who is hospitalized and discharged back to the Community. Complex patients requiring follow up and care from multiple service providers are identified by a Maccabi nurse reviewer in the hospital and referred to one of the 5 multidisciplinary regional compass units in the area where the patient lives (each unit has a doctor, nurse, social worker, clinical pharmacist and a secretary) which develops a care plan for the patient based on the discharge summary and family doctor instructions.
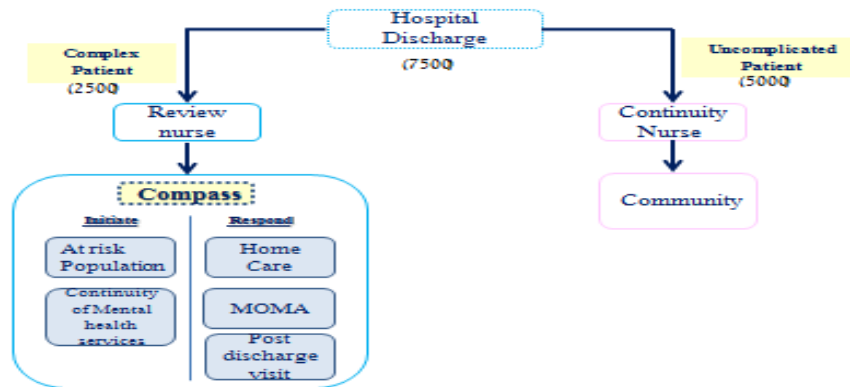
Figure 10 – Maccabi Compass Continuity of Care model.

2.4.1.4 Current Strategies for Innovation – Full Integration with Case Management

In 2010, Assuta Medical Centres won a Ministry of Health tender to build a new public hospital in the city of Ashdod, the fifth largest city in Israel, with a quarter of a million residents. Assuta, together with Maccabi and the Municipality of Ashdod, decided to create an integrated care system in the city of Ashdod, using the hospital as a hub, but dedicated to personalized care for all residents with the emphasis on care in the community and in the patient's home. All of the Health Plans have agreed to collaborate with Assuta and to join this model.

Assuta Ashdod opened its doors on June 4 2017. Digital interfaces have already been developed between the Assuta Ashdod hospital and Maccabi that will enable a seamless transition between the hospital and the Community. Likewise, interfaces have been developed to enable sharing of information between Assuta, Maccabi and the Municipality's Social and Community Services. Integrated Care for unplanned hospitalization of complex patients due to exacerbation of their condition who are discharged back to the community (CONNECARE Case Study 1) as well as peri-surgical care with post-discharge follow-up (CONNECARE Case Study 2) have become key processes within Assuta and Maccabi's plans for developments of Adaptive Case Management in Ashdod within the project lifetime:

- Assuta is developing a case management system that will identify complex patients requiring integrated care in the Emergency room/admission to the hospital (CONNECARE Case 1) and alert the appropriate case manager so that she can assure full integration of the care within the hospital among all clinicians and departments as well as immediately begin to coordinate with the Maccabi Nurse coordinator to begin anticipatory discharge planning. Likewise, the Municipality Social Services will receive an electronic notification of the patient's admission so

that social services, personal caregiver services and other social support services will immediately come into play at the time of discharge without delay.

- Assuta is developing a prehabilitation program for complex patients scheduled for elective major surgery (CONNECARE Case 2) that will be initiated as soon as the decision has been made to operate and the surgery has been scheduled. This will include a physical activity regimen, a nutrition plan, medication monitoring and psychological support

- Maccabi will open an Integration Unit (an extension/branch of the regional Compass/Continuity of Care Unit) that will be physically located within the Assuta Ashdod hospital and consist of Nurse Integrators, a social worker and a secretary that will work as a team with the Assuta Case manager to develop the discharge plan. Each complex patient that is discharged home (both CONNECARE Case studies 1 and 2) will be assigned a Nurse Integrator who will be responsible for closely monitoring the patient after discharge and coordinating his/her follow up care. Within the CONNECARE program we are planning for intensive proactive monitoring for up to 3 months, but Maccabi expects to continue to monitor these patients for up to a year.

These processes are being co-designed with the clinicians in the hospital as well as the clinicians in the community (particularly primary care physicians) as described in D2.4 - section 2.2.4.

2.4.2 Existing technological setting

2.4.2.1 Maccabi Healthcare Services – Integrated Healthcare Data

Maccabi Healthcare Services, the second largest of the Health Plans (today covering more than 2 million people – 25% of the population) was the pioneer, the first to implement Electronic Medical Records in 1993 and has continued to lead the way in technological development. Today, all services – including primary and secondary care, laboratory, imaging, prescriptions, all diagnostic services, all treatment centers for Maccabi members are computerized (**Figure 11**) and digitally integrated (**Figure 12**).
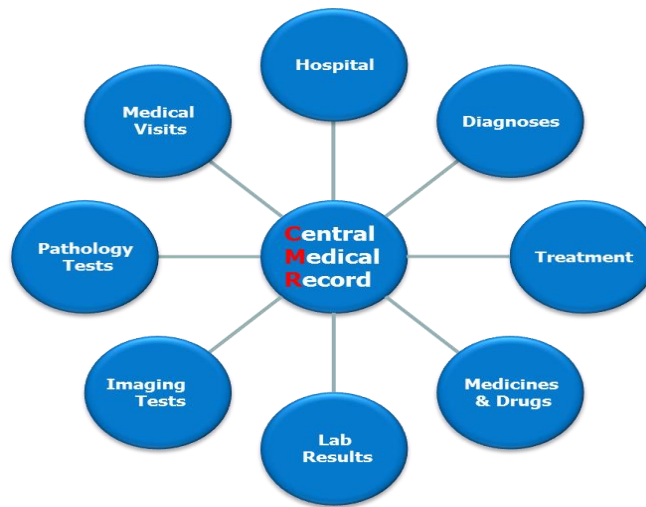
Figure 11 – Central Medical Record

Underlying this system is a sophisticated Clinical Decision Support System that alerts clinicians to potential drug interactions at the time of prescribing, reminders to refer patients for tests in accordance with their personalized needs (for example, to refer a diabetic patient for a HbA1c test or an eye exam, to refer all women over 50 for a mammogram once every 2 years and more). All systems are closed circuit .so that once a clinician has referred a patient for any kind of test, he automatically gets the results in his medical record with an alert about all results received as soon as he opens his computer. Since 2001, Maccabi has a member web portal enabling all members access to their medical information and this has continuously evolved so that it is now interactive – members get the same reminders that their doctors get and they can ask for prescription renewals or referrals on line and receive an electronic prescription or referral in the portal, make both physical and virtual appointments, and receive guidance and education to help them manage their health. Maccabi has developed an app that enables both doctors and patients to access the EMR information on their smartphone.
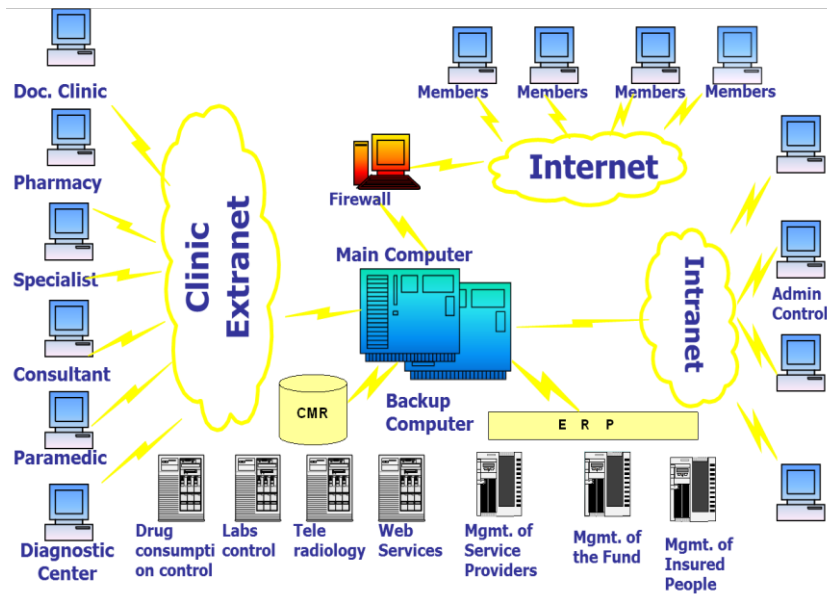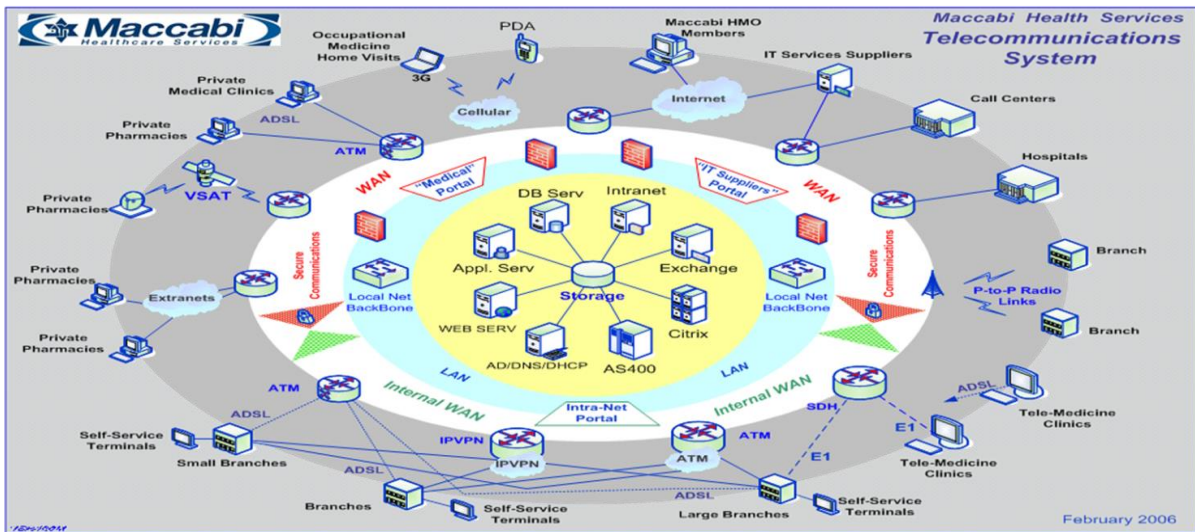
Figure 12 – Integrated Information System

Figure 13 – Maccabi telecommunication System

2.4.2.2 Compass Continuity of Care System

As described above (Section 2.4.1.3), complex patients requiring follow up and care from multiple service providers are assigned to a care plan that is entered into the Compass computerized system (**Figure 14 - Compass Task Coordination and System Architecture.**, which is a subset of the Central EMR) and tasks are assigned to all of the relevant care providers who receive their tasks electronically - through the EMR system. The Compass unit has access to the patients' EMR information and follows up to make sure all tasks assigned are performed and to assure that the patient's recovery is progressing as anticipated.
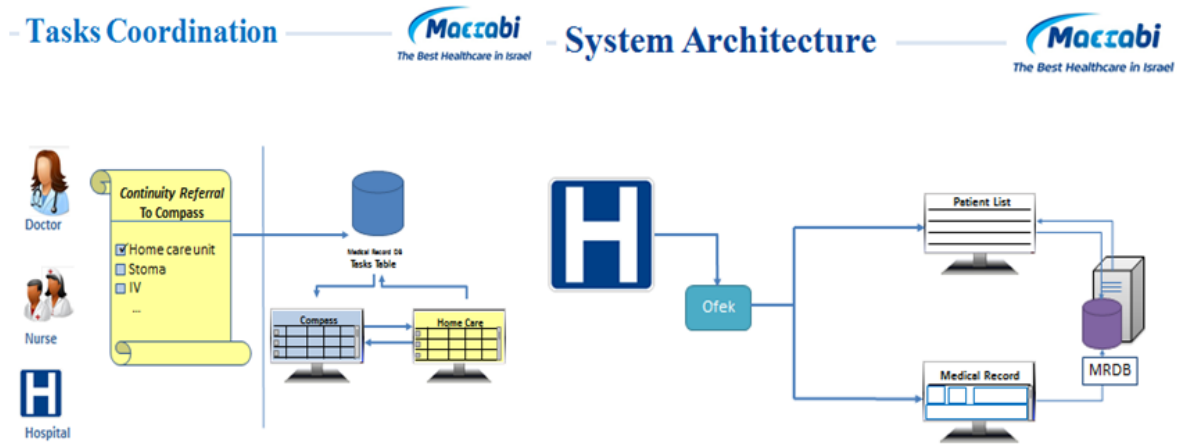
Figure 14 - *Compass Task Coordination and System Architecture.*

2.4.2.3 Assuta Computerized Clinical System

Assuta Medical Centre hospitals and clinics are all fully computerized with a central medical record and closed circuit systems that link the laboratory, imaging, all diagnostic services, the operating room, intensive care, all departments and pharmacy to the central EMR. Assuta operates a Call Centre using CRM (Customer Relation Management) Technology that is also linked to the EMR and provides proactive follow up for all patients discharged from the hospital to assure that the patient understands and is following his/her discharge instructions, to answer questions and provide support, and to detect potential complications. Both doctors and nurses have apps that enable them to access the EMR from their mobile phones

2.4.2.4 Linking Hospital and Community Information Systems

The major gap until recent years has been sharing patient information between the hospital and the community, but the Ministry of Health has put in place a system enabling the clinician in the community to see his patient's record while in the hospital and enabling the medical staff in the Emergency Room and the hospital to see the patient's Health plan medical record.

Maccabi owns Assuta Medical Centres, the largest private hospital network in Israel, and so has developed and continues to develop increasing digital integration between them. Assuta has an EMR at the centre of a fully computerized system that integrates all of the hospital's services. This system operates network-wide in all of Assuta's hospitals. Assuta doctors can access the Maccabi Physician Portal and have access to full medical record information, while outpatient test results as well as discharge summaries are sent to the Maccabi EMR. The new layer to be added to this in Ashdod will be the integration and sharing of information with Social Care provides including the Municipality's Social Service

Department. The implementation of CONNECARE with its Case studies will leverage, extend and enhance these integrated care and adaptive case management processes to a new level

3. Conclusions

The document provides a comprehensive description of the organisational and technological dimensions that have been considered during the co-design process of CONNECARE case studies to generate the complete set of functional specifications of the CONNECARE case studies and supporting ACM tools (smart ACM platform for collaborative work among healthcare professionals and self-management tools for patients). These dimensions have been the basis for generating a first set of functional specifications for current technological developments in project work packages 3 (Smart Adaptive Case Management) and 4 (Smart Self-management and Monitoring). In addition, this document describes existing site-specific organizational and technological settings that should ultimately converge with project-specific ACM outcomes to effectively support CONNECARE case studies. Ultimately, this document allows to continue the co-design process of CONNECARE integrated care services and supporting adaptive case management technologies.

4. References

[1]   Object Management Group. Documents Associated With Case Management Model And Notation™ (CMMN™), Version 1.1 - Beta 2016.

[2]   WHO. Innovative Care for Chronic Conditions: Building Blocks for Action. Geneva: World Health Organization (WHO/MNC/CCH/02.01).
URL:http://www.who.int/chp/knowledge/publications/icccreport/en/. Accessed: 2013-08-20.
(Archived by WebCite® at http://www.webcitat. Geneva World Heal Organ 2002.

[3]   "Innovative approaches for chronic diseases in public health and healthcare systems". 2010.
"Innovative Approaches Chronic Dis Public Heal Healthc Syst Counc EU 3053rd Employment, Soc Policy Heal Consum Aff 2010;32:2–4.

[4]   McCreary L. Kaiser Permanente's innovation on the front lines. Harv Bus Rev 2010;88:92,94-97,126.

[5]   Atkins D, Kupersmith J, Eisen S. The Veterans Affairs experience: comparative effectiveness research in a large health system. Heal Aff 2010;29:1906–12. doi:10.1377/hlthaff.2010.0680.

[6]   True G, Butler AE, Lamparska BG, Lempa ML, Shea JA, Asch DA, et al. Open access in the patient-centered medical home: lessons from the Veterans Health Administration. J Gen Intern Med 2013;28:539–45. doi:10.1007/s11606-012-2279-y.

[7]   NEXES. Supporting Healthier and Independent Living for Chronic Patients and Elderly. CIP-ICT-PSP-225025 n.d.

[8]   Cano I, Alonso A, Hernandez C, Burgos F, Barberan-Garcia A, Roldan J, et al. An adaptive case management system to support integrated care services: Lessons learned from the NEXES project. J Biomed Inform 2015;55:11–22. doi:10.1016/j.jbi.2015.02.011.

[9]   Case Management Society of America 2016.
http://www.cmsa.org/Home/CMSA/WhatisaCaseManager/tabid/224/Default.aspx (accessed June 19, 2017).

[10]   Ross S et al. Case management: What it is and how it can best be implemented? 2011. https://www.kingsfund.org.uk/publications/case-management (accessed June 5, 2017)

[11]   Allweyer T. BPMN 2.0: Introduction to the Standard for Business Process Modeling. . Books on Demand GmbH; 2010.

[12]   Cano I, Alonso A, Hernandez C, Burgos F, Barberan A, Roldan J, et al. An Adaptive Case Management System to support Integrated Care Services: Lessons Learned from the NEXES Project. J Biomed Inform 2015;55:11–22. doi:10.1016/j.jbi.2015.02.011.

[13] Hauder M, Pigat S, Matthes F. Research Challenges in Adaptive Case Mangement : A Literature Review. Adapt 2014 3rd Int Work Adapt Case Manag Other Non-Workflow Approaches to BPM 2014. doi:10.1109/EDOCW.2014.24.

[14] WB R. Health Care as a Complex Adaptive System: Implications for Design and Management. Bridg Spring 17-25 2008.

[15] Marin MA. Introduction to the Case Management Model and Notation (CMMN) 2016.

[16] Font D, Escarrabill J, Gómez M, Ruiz R, Enfedaque B, Altimiras X. Integrated Health Care Barcelona Esquerra (Ais-Be): A Global View of Organisational Development, Re-Engineering of Processes and Improvement of the Information Systems. The Role of the Tertiary University Hospital in the Transformation. Int J Integr Care 2016;16:8. doi:10.5334/ijic.2476.

[17] Cano I, Dueñas-Espín I, Hernandez C, de Batlle J, Benavent J, Contel JC, et al. Protocol for regional implementation of community-based collaborative management of complex chronic patients. Npj Prim Care Respir Med 2017;27:44. doi:10.1038/s41533-017-0043-9.

[18] Hernández C, Alonso A, Garcia-Aymerich J, Grimsmo A, Vontetsianos T, García Cuyàs F, et al. Integrated care services: lessons learned from the deployment of the NEXES project. Int J Integr Care 2015;15:e006.

[19] Department of Health. Catalonia Health Plan for 2016-2020 (in Catalan) 2016.

[20] Sanchez-de-la-Torre M, Nadal N, Cortijo A, Masa J, Duran-Cantolla J, Valls J, et al. Role of primary care in the follow-up of patients with obstructive sleep apnoea undergoing CPAP treatment: a randomised controlled trial. Thorax 2015;70:346–52. doi:10.1136/thoraxjnl-2014-206287.

[21] Turino C, de Batlle J, Woehrle H, Mayoral A, Castro-Grattoni AL, Gómez S, et al. Management of continuous positive airway pressure treatment compliance using telemonitoring in obstructive sleep apnoea. Eur Respir J 2017;49:1601128. doi:10.1183/13993003.01128-2016.

[22] Barberan-Garcia A, Vogiatzis I, Solberg HS, Vilaró J, Rodríguez DA, Garåsen HM, et al. Effects and barriers to deployment of telehealth wellness programs for chronic patients across 3 European countries. Respir Med 2014;108:628–37. doi:10.1016/j.rmed.2013.12.006.

[23] Department of Health C. Catalonia Health Plan for 2016-2020 (in Catalan) 2016. http://salutweb.gencat.cat/web/.content/home/el_departament/Pla_salut/pla_salut_2016_2020/D ocuments/Pla_salut_Catalunya_2016_2020.pdf.

[24] Barberan-Garcia A, Ubré M, Roca J, Lacy AM, Burgos F, Risco R, et al. Personalised Prehabilitation in High-risk Patients Undergoing Elective Major Abdominal Surgery. Ann Surg 2017:1. doi:10.1097/SLA.0000000000002293.

[25]   Whittington JW, Nolan K, Lewis N, Torres T. Pursuing the Triple Aim: The First 7 Years. Milbank Q 2015;93:263–300. doi:10.1111/1468-0009.12122.

[26]   Berwick DM, Nolan TW, Whittington J. The Triple Aim: Care, Health, And Cost. Health Aff 2008;27:759–69. doi:10.1377/hlthaff.27.3.759.

5. ANNEX I - Promotion of physical activity in Barcelona: existing implementation plans in a real-world scenario

A recent study [22] assessing barriers for deployment of novel collaborative self-management Physical Activity (PA) services was useful to identify the requirements for large scale deployment of the novel approach. Moreover, the approach shall also have potential for generalization to other interventions aiming at promoting healthy lifestyles, as part of regional integrated care strategies for chronic patients. Accordingly, implementation in a real-world setting in Barcelona aims to address those unmet requirements, namely: i) Adaptive Case Management design of the PA services engaging both patients and healthcare professionals; ii) Enhanced technological support for self-management; iii) Evaluation strategies including structured indicators during and beyond deployment of the novel services; and, iv) Implementation of innovative business models.

The real-world implementation (**Figure 15**) has been designed as part of the 2016-2020 Health Plan in Catalonia [23] and involves implementation of three collaborative self-management services designed to promote PA in three study groups representative of different layers of the population-based risk stratification pyramid, namely:

i) Prehabilitation for high risk candidates to major surgery (**Prehabilitation study - CONNECARE Case Study 2 & 3),** (n=1,000). A recent randomized controlled trial (RCT) carried out in high-risk candidates to major abdominal surgery has demonstrated high efficacy of prehabilitation reducing postoperative complications in these patients [24]. Implementation of the Prehabilitation study as mainstream service at Hospital Clinic de Barcelona will allow to assess cost-effectiveness.

ii) Community-based rehabilitation and promotion of PA for clinical stable chronic patients with moderate to severe disease (**Rehabilitation study,** (n=800)). A previous non-randomized pilot study [22] identified determinants of adoption of a community-based rehabilitation service for chronic patients, as well as its potential for health-value generation. The main objective of the Rehabilitation study is to assess both cost-effectiveness and sustainability of a community-based program combining exercise training and promotion of PA in clinically stable chronic patients showing one or more of the following target disorders: i) Chronic obstructive pulmonary disease (COPD) or other chronic respiratory conditions; ii) Cardiovascular disorders (CVD); and/or iii) Type II diabetes mellitus (T2DM).

iii) Promotion of PA and healthy lifestyles for citizens at risk and patients with mild disease (**Lifestyle study,** (n=1,800)). The Lifestyle study will assess large-scale deployment and sustainability of a portfolio of services promoting PA and healthy lifestyles for citizens at risk for the targeted chronic conditions and patients showing mild target disease(s). The study will also assess the impact of the intervention on health-related quality of life.
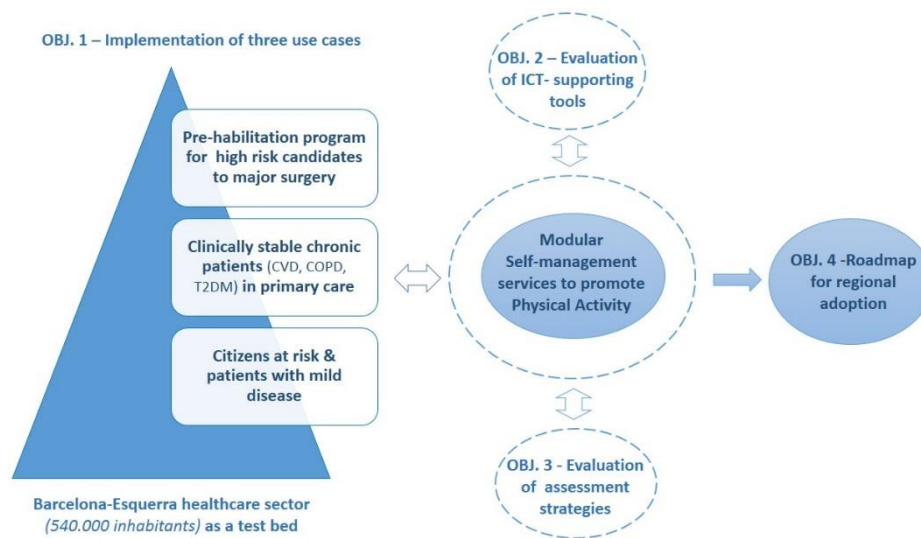
Figure 15 - Objectives of the implementation studies. The figure displays the four main objectives of the protocol considered as pivotal steps to achieve regional adoption of collaborative self-management services promoting physical activity across health-care tiers. Deployment of three use cases in one of the healthcare sectors of the city of Barcelona will target chronic obstructive pulmonary disease (COPD), cardiovascular disorders (CVD) and type 2 diabetes mellitus (T2DM). An Adaptive Case Management approach will be adopted. ICT stands for information and communication technologies.

The implementation of the above collaborative self-management services will adopt a Triple Aim approach [25,26] [29, 30] for assessment of the three implementation studies and to select key performance indicators to be used for follow-up of the services beyond the implementation phase. Finally, the implementation studies will serve to generate a roadmap for adoption of the PA services in the region of Catalonia (7.5 million citizens).

The real-world implementation has been conceived (**Figure 16**) as a twenty-four months test bed period plus a third year wherein the initiative will be deployed at regional level. At the end of the second year (2018), three main achievements will be in place. Firstly, the three implementation studies will be adopted as mainstream services in one of the four healthcare sectors of the city of Barcelona, Barcelona-Esquerra (Ais-Be) (540.000 inhabitants). A second milestone will be the elaboration of a plan for generalization of the PA services approach to other non-pharmacological interventions. Thirdly, a roadmap for regional deployment of the PA services in Catalonia (7.5 million habitants) will be launched.
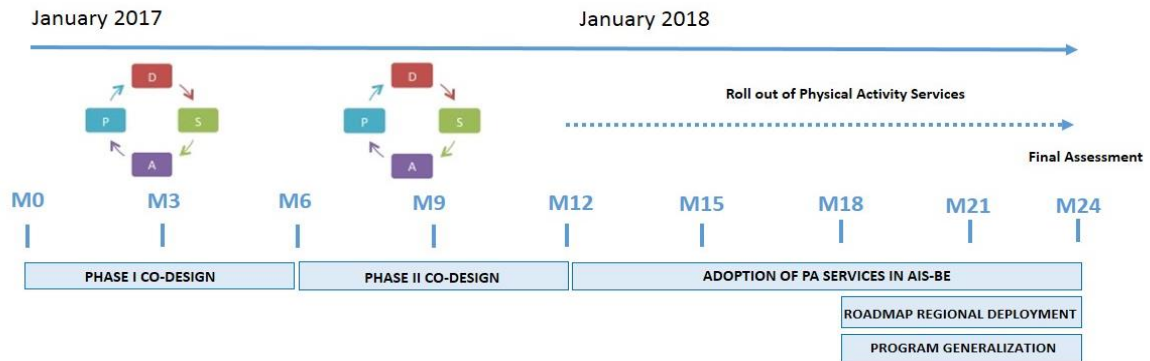
Figure 16 - *The three implementation studies will be conducted in parallel. The 24-month lifespan of the programs will be divided in two main phases of approximately one-year duration each. The initial co-design Plan-Do-Study-Act (PDSA) cycle will be devoted to co-design and refinement of the service workflows, set-up and assessment of ICT-supporting tools, and identification of key performance indicators. During the second PDSA cycle, the program will be adopted at pilot level in the healthcare sector. This second phase will be used to fine tune the services, assess and refine ICT-supporting tools, as well as to consolidate the long-term evaluation plans. The two PDSA cycles will have a multidisciplinary approach including patients and professionals with different profiles (i.e. physiotherapists, nurses, general practitioners, medical specialists and technologists).*

From a technical point of view, plans for developments of the three collaborative self-management services have been organised on a technological architecture based on the CONNECARE digital health framework first described in deliverable *D5.1 – Collaborative Digital Health Framework*, which allows scalability within the interoperability frameworks of "Barcelona-Esquerra" and Catalonia, while being provider independent. Ultimately, this should also allow the Barcelona site to accommodate with different on-going developments and suppliers.