



# CONNECARE

## WP3 – SMART ADAPTIVE CASE MANAGEMENT SYSTEM

### D3.6: FINAL SMART ADAPTIVE CASE MANAGEMENT SYSTEM

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

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<b>Abstract</b>	This deliverable goes with the final release of the Smart Adaptive Case Management system (SACM) by TUM and ADI, integrated to the SMS by EURECAT and the contribution of UNIMORE for the clinical decision support systems.
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## Executive Summary

This deliverable goes with the final release of the Smart Adaptive Case Management system (SACM) by TUM and ADI, under the supervision of EURECAT and the contribution of UNIMORE for the clinical decision support systems, with particular reference to the one on mapping. In particular, technical details on the implemented system are given together with the screenshots of the final system to show the look-and-feel of the system. This version of the system is the final one used during the clinical studies and has been improved all the time thanks to the continuous feedback by the involved clinicians and according to new requirements.

As already documented in the deliverable D3.3 “First Smart Adaptive Case Management System”, following a co-design approach for the project with all the clinical partners, first of all the requirements of the SACM have been gathered by TUM in conjunction with EURECAT. When the implementation studies started, as already reported in the WP6 deliverables, clinicians had access to a xls file “Implementation Log” in which they reported bugs, technical issues, and requests/suggestions for improvements, especially regarding usability. This deliverable reports the implementation work carried out from the Study- to the Final-Release and also proposes an outlook for future implementation and scaling-up.

The work summarized in this document is based on the work made by TUM, ADI, and EURECAT in WP3. According to the CONNECARE fundamentals, that work has been done in collaboration with all the partners, especially clinical ones, and decisions came from the co-design approach followed in WP2. Moreover, the work presented in this deliverable is strictly related to the overall work made in WP3, thus including the work on clinical decision support systems by UNIMORE. Therefore, these previous deliverables are highly recommended to be read:

Number	Title	Description
D2.1	Cook-book for project development	The document provides an overall view of the CONNECARE project, and describes the procedures for its development. The deliverable indicates the different phases of the project, with an emphasis on how PDSA cycles will be structured. Overall, the CONNECARE project does not aim at a rigid integrated care solution that needs to be adopted by all potential deployment sites but to a flexible solution that has high potential for generalization at the EU level. In this sense, innovative methodologies involving both global and local stakeholders have been adopted.
D2.4	Case studies description and the associated co-design	The document provides a complete view of case study definitions as a product of the co-design process completed so far. It provides full details on the 1st PDSA cycle from the clinical perspective, summarizing the objectives and results of all held meetings and activities, as well as all the feedback provided to technical partners. Moreover, the current document includes detailed site-specific case studies definitions and associated workflows.



		Finally, full details on functional and non-functional requirements of the CONNECARE Smart Adaptive Case Management (SACM) platform And Self-Management System (SMS) are provided.
D3.3	First Smart Adaptive Case Management	This deliverable goes with the first release (namely, Study Release) of the Smart Adaptive Case Management system (SACM) by TUM and ADI, under the supervision of EURECAT and the contribution of UNIMORE for the first clinical decision support system.
D3.4	Stratification and Mapping DSS	This deliverable has the threefold goal of (i) reporting on the activities carried out to improve the 1st prototype of the risk assessment DSS presented in D3.2 “First Screening and Risk Stratification DSS”, (ii) reporting the same for the mapping DSS currently released in CONNECARE production environment, and (iii) describing the resulting software artefacts. Accordingly, section 1 motivates and gives context to the work done, section 2 recaps the main characteristics of the DSS for risk assessment and summarises the improvements done, section 3 introduces the DSS for mapping by describing its functionalities and architecture, section 4 looks forward to future iterative improvement steps, and section 5 concludes the document.
D3.5	Self-Adaptive Clinical Pathways CDSS	This deliverable has the goal of reporting on the activities carried out to develop a 1st prototype of the CDSS for clinical pathways. Accordingly, Section 1 introduces the document by motivating the need for the Pathways CDSS and its goals, Section 2 reports on the requirements collection stage informing the Pathways CDSS design, Section 3 briefly summarises the state of art of research works in clinical pathways related ICT tools, Section 4 describes the design of the Pathways CDSS, Section 6 describes a preliminary analysis of the available datasets, Section 6 discusses next steps, and Section 7 concludes the document.

This deliverable reflects only the author’s view and the European Commission is not responsible for any use that may be made of the information it contains. (Art. 29.5)

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## 1. The Back-End

The SACM builds upon SocioCortex, a social information modeling platform developed by the TUM. Especially for the CONNECARE project, SocioCortex was adapted to meet specific requirements for the usage in the healthcare domain.

### 1.1 SocioCortex for Healthcare

In the following section, we summarize the technical capabilities of the SocioCortex Platform for healthcare and highlight the CONNECARE-tailored adaptations to it.

Figure 1 provides an overview of the layers of the SocioCortex reference architecture. The graphical representation emphasizes that each layer adds new abstractions (e.g., an access control model) to the abstractions of the layers below. The abstractions are made accessible to clients via RESTful APIs for introspection or modification. Each concept (e.g., Principal, Group, User, Membership) is mapped to a separate resource in the REST API. The semantic relationships between the concepts (association, aggregation, sub-classing) are mapped to (bi-directional) links between resources or specialized resources.

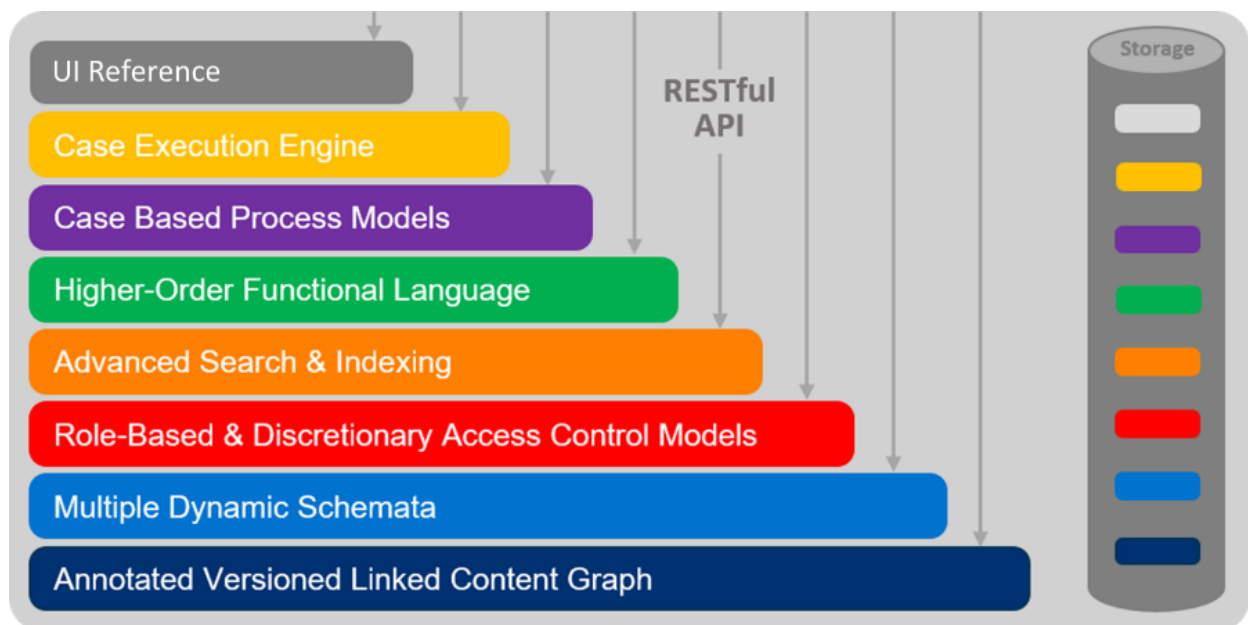


Figure 1 - Layers of the reference architecture.

Figure 2 shows all the capabilities that are provided in each layer of the reference architecture and their semantic relationships (capability A uses capability B, capability A extends capability B). The colour coding links the elements to the layers depicted in Figure 1 and the concepts in the conceptual model in Figure 3. We found this capability map to be a very useful starting point for core developers of the platform to understand the key concepts and dependencies in the architecture.

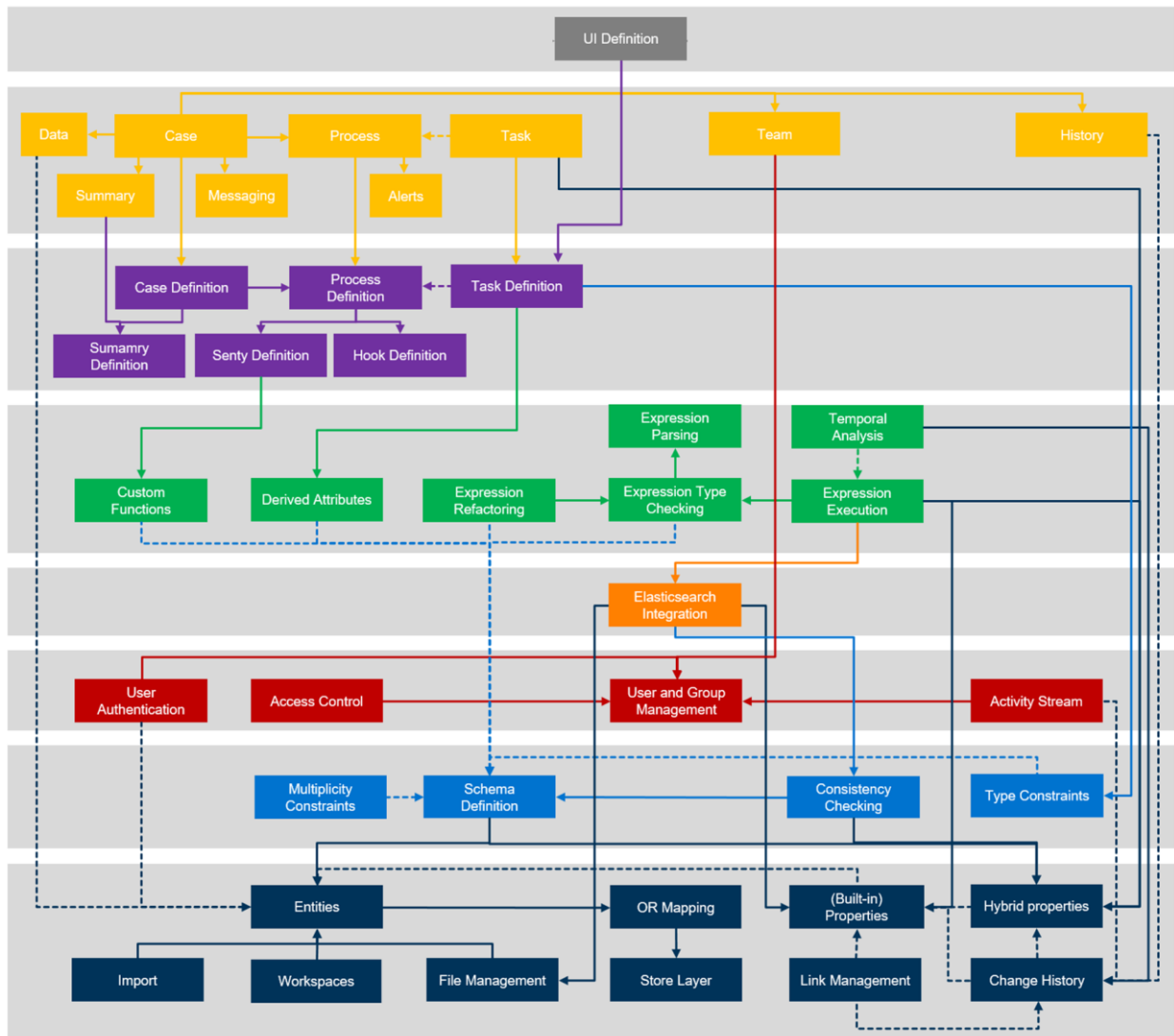


Figure 2 - Capabilities ordered according to the conceptual layers. A solid line represents the usage of a certain capability and a dashed line represents extended functionality.

The underlying meta-model of cooperative information systems (see Figure 3) builds on the already introduced core concepts of Workspaces as containers (name spaces) for *Entities*, *EntityDefinitions*, *Attributes*, and *AttributeDefinitions*. These concepts structure the model inside a Workspace and capture its current state. An Entity consists of a collection of Attributes, and the Attributes are stored as a key-value pair. The attributes have a name and can store an ordered list of values of different types, for example, strings or references to other Entities. The user can create an attribute at run-time to capture structured information about an Entity. An *EntityDefinition* allows users to refer to a collection of similar entities and their common schema, e.g., organizations, persons, amongst others. The *EntityDefinition* consists of multiple *AttributeDefinitions*, which in turn contain multiple validators such as multiplicity validator, string value validator, and link value validator. Additionally, an individual attribute and its values can be associated with validators for maintaining integrity constraints.



A *CaseDefinition* is a template for all related case instances and links to a root *EntityDefinition* which describes the schema of the case data. Every *CaseDefinition* consists of multiple *ProcessDefinitions* that are either a complex *StageDefiniton*, a single *HumanTaskDefinition* or an *AutomatedTaskDefinition*. *StageDefintions* represent a container that is used to group either sub *StageDefintions* or *TaskDefinitions*. Preconditions to the activation of a stage are expressed as *SentryDefinitions* that either depend on some previously accomplished Process elements or expressions (Boolean predicates) related to the case data. In order to receive notifications on state changes of a Process element, it is possible to define *HookDefinitions* related to a *ProcessDefinition*. These hooks can be used to integrate services from third-party systems (with REST APIs). Additionally, *SummarySectionDefintions* are used to create short summaries (data views) based on the data created by the Case.

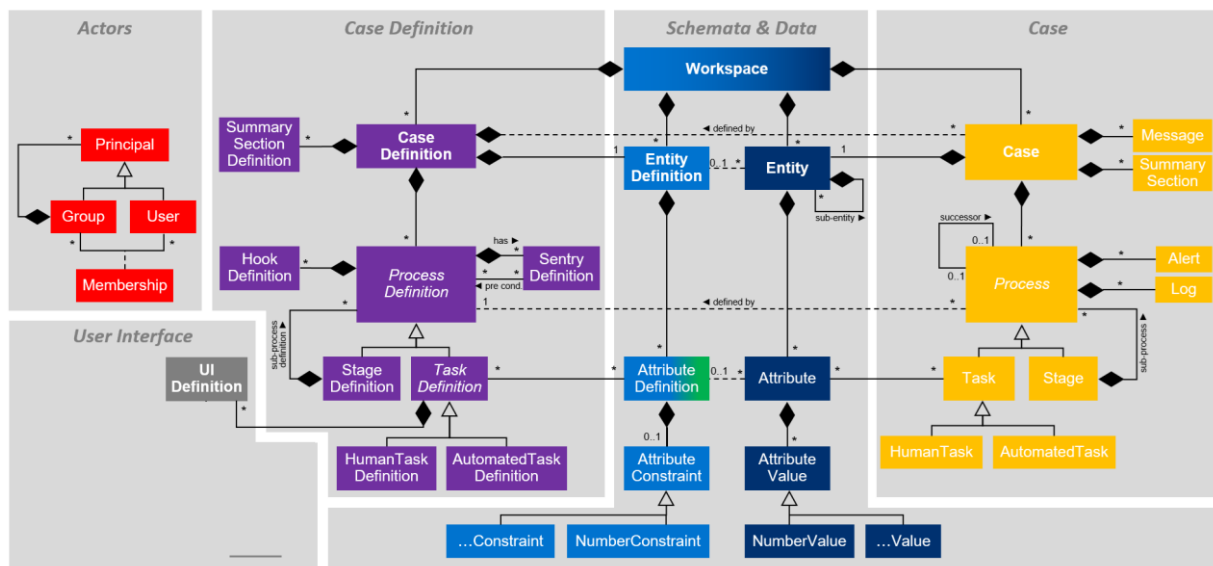


Figure 3 - Conceptual Meta-Model.

The above summary is part of a publication entitled “A Practice-Proven Reference Architecture for Model-Based Collaborative Information Systems” [1] that describes the generic model-based reference Architecture of SocioCortex that is used in CONNECARE. Additionally, we published a paper entitled “A holistic model-based adaptive case management approach for health-care” [2] that illustrates how the modelling elements are used within our clinical trials. Based on the requirements we derived from the SACM compared existing tools [3].

## 1.2 Working with Cases and Questionnaires

The SACM supports an XML-based domain-specific language (DSL) to model cases and questionnaires. Throughout the CONNECARE project, the TUM and EURECAT supported the domain experts at each clinical site in creating the case and questionnaire models. To ensure that users deploy only working



models, the SACM supports complex unit tests that execute and simulate each model before putting into productive use.

Questionnaire attributes are often dynamic, e.g., a measured series of values. To support complex and dynamic attributes and answers, SocioCortex implements a powerful query language called MxL. Using MxL allows domain experts to model highly dynamic and complex processes.

To facilitate the onboarding process of new domain experts, the SACM provides a minimal XML skeleton of a simple case as a starting point.

Even though the primary purpose of the SACM is serving as a backend for the frontend application, it is highly modular. The RESTful API allows any other authorized and authenticated application to use and leverage its capabilities.

During the evaluation phase, it was required to integrate the SACM's data into an analytical environment. Therefore, the SACM implements a specific data export endpoint that allows users to extract patient and case data from the system conveniently.

During the operational period of the SACM, we noticed that some patient-questionnaires were completed with input errors, e.g., wrong spelling of a name. Therefore, a functionality to adapt and correct already completed questionnaires was added to ensure always correct answers and high-quality data.

## 2. The Front-End

The Professional Interface is the front-end to the SACM back-end. It is a web app written in Angular interfacing. It interfaces to the SACM using RESTful APIs published by the SACM. To support authentication and user management the Professional Interface interfaces to RESTful APIs of the User Identity Management from Eurecat.

The functionality of the Professional Interface was designed based on the Case Studies carried out in Work Package 2. A series of wireframe designs were created using the Balsamiq Mockups tool. This tool allowed the basic outline of the screens and their interactions to be easily sketched and shared for review with the technical and clinical teams.

### 2.1 Dashboard

Following a successful log in the professional is presented with a dashboard. As shown in Figure 4, this provides navigation to the key functional areas and a quick access to the immediate tasks, messages and notifications. Clicking on a notification, message or task takes the clinician directly to it. The Actions allows the clinician to acknowledge or filter the column.

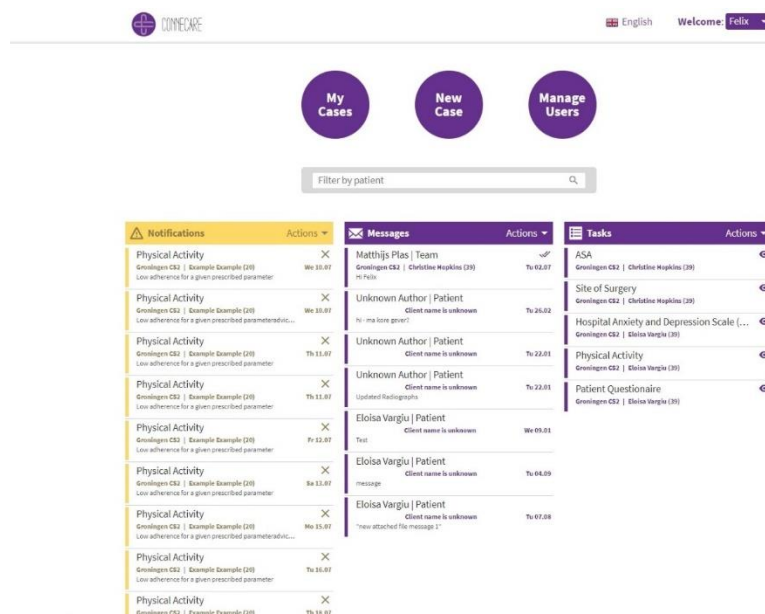


Figure 4 - Dashboard.

In the case of Lleida, there is also the option to open the Mapping DSS, clicking on “Go to mapping” (see Figure 5). The mapping functionality is described in Section 3.

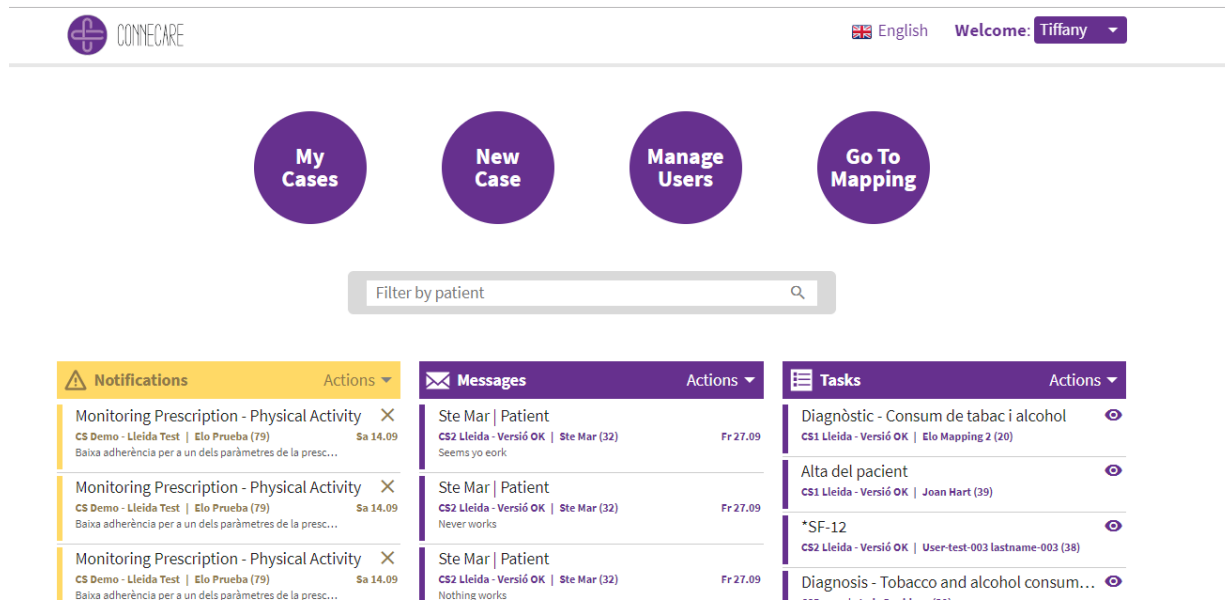


Figure 5 - The dashboard in the case of Lleida.

## 2.2 Manage Users

The Manage Users functional area provides a set of pages for a Professional to create and edit Patients. Pages are also provided to create and edit Professionals, for users with the correct rights.

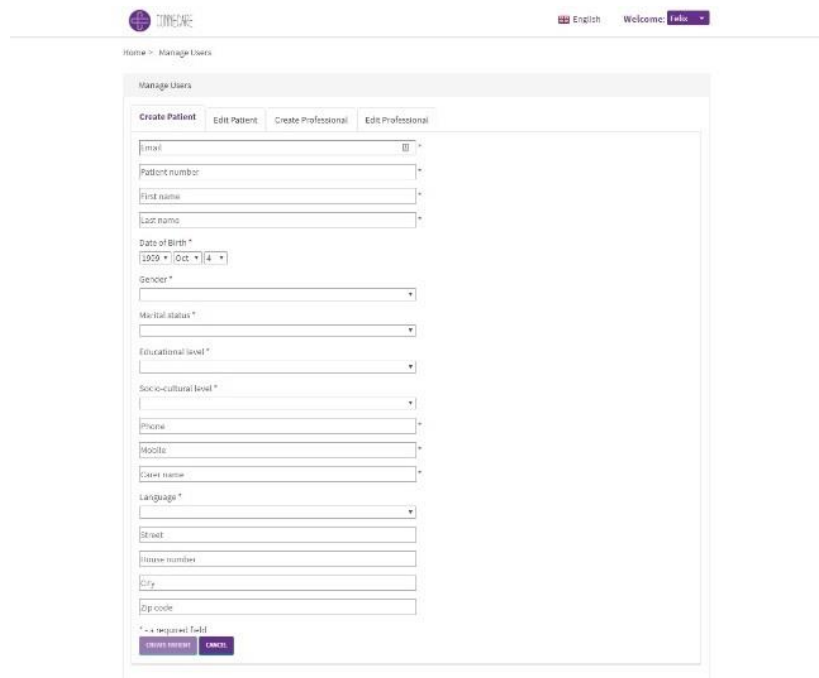


Figure 6, Figure 7, Figure 8, and Figure 9 show the creation and edit of patients and professionals.



The screenshot shows the 'Manage Users' interface with the 'Create Patient' tab selected. The form contains the following fields: Email, Patient number, First name, Last name, Date of Birth (with a calendar icon), Gender, Marital status, Educational level, Socio-cultural level, Phone, Mobile, Care name, Language, Street, House number, City, and Zip code. A legend indicates that an asterisk (\*) denotes a required field. At the bottom of the form are 'Cancel' and 'OK' buttons.

Figure 6 - Manage users: patient creation.

The screenshot shows the 'Manage Users' interface with the 'Create Professional' tab selected. The form contains the following fields: Email, First name, Last name, and Language. Below these is a 'Roles' section with a list of professional roles: Primary Care Nurse, clinician, admin, case manager, nurse, anesthesiologist, admin-office, physician, diet, physiotherapist, nutritionist, psychologist, social carer, primary-care-clinician, lab-technician, interventionalists, data manager, and secretary. A legend indicates that an asterisk (\*) denotes a required field. At the bottom of the form are 'Cancel' and 'OK' buttons.

Figure 7 Manage users: professional creation

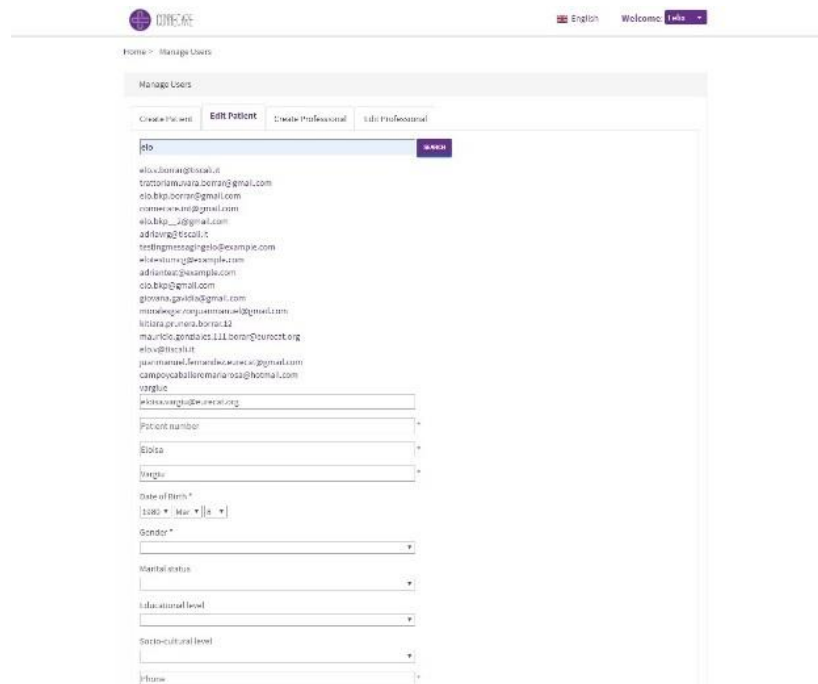


Figure 8 – Manage users: Editing of patient data.

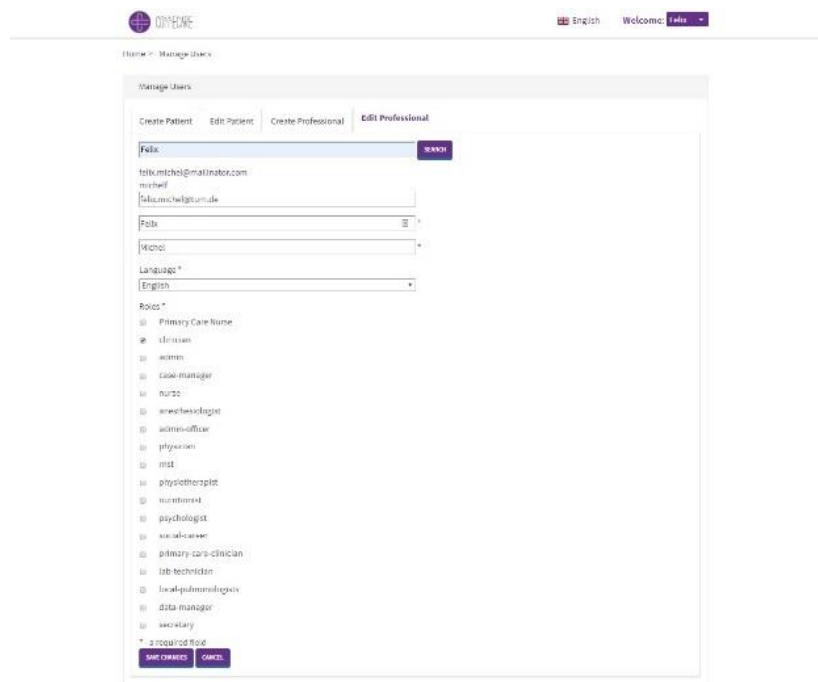


Figure 9 - Manage users: editing of the data of a professional.

## 2.3 New Case

The New Case page allows a Professional to create a new case from the list of available case models for that site (Figure 10).



Figure 10 - Example of creation of a new case, in the UMCG site.

## 2.4 My Cases

The My Cases page provides the Professional with a list of all the cases assigned to him/her (Figure 11). Clicking on the case row takes the clinician directly to that case. Tool tips on the notifications, messages and tasks icons provide additional information.

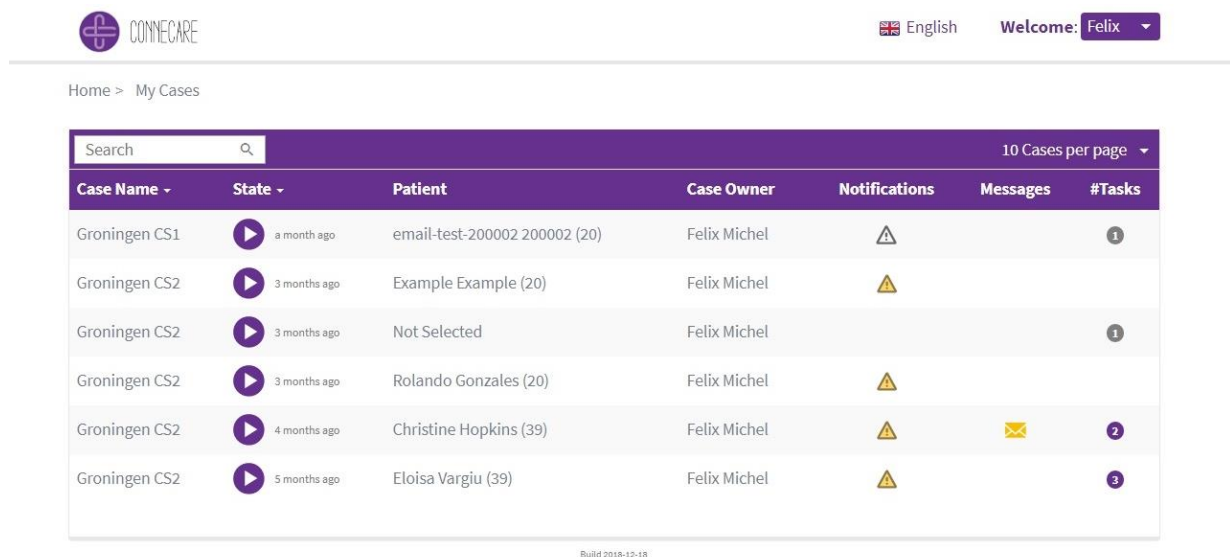


Figure 11 - List of cases.

## 2.5 Case Summary

When a Professional selects a case from their list, they are taken into the data pages for that case. The landing page for each case is a Case Summary page. The format and data presented on the case



summary page is configured by SACM backend and may differ depending on the selected case study and site. Figure 12 shows an example in the case of Groningen, Case Study 2.

Home > My Cases > Eloisa Vargiu

**Groningen CS2 - Eloisa Vargiu** Age: 39 Current Stage: Case Evaluation Case ID: r1a3liicunbp Case Actions

Summary Process Data Team Notifications 2 Messages Notes

Nutritional	
NRS Score	3
BMI range indicator	1

Frailty	
Groningen Frailty Indicator	11
ASA	ASA 4
Charlson Comorbidity Index (unadjusted)	21

**Site of Surgery**

UNHARMED SURGICAL SITE

Functional	
iADL Score	6
ADL Score	7

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Figure 12 - An example of the summary page for Case Study 2 in Groningen.





## 2.6 Case Execution

The case process tab shows the stages of a case and the available tasks for each stage (see

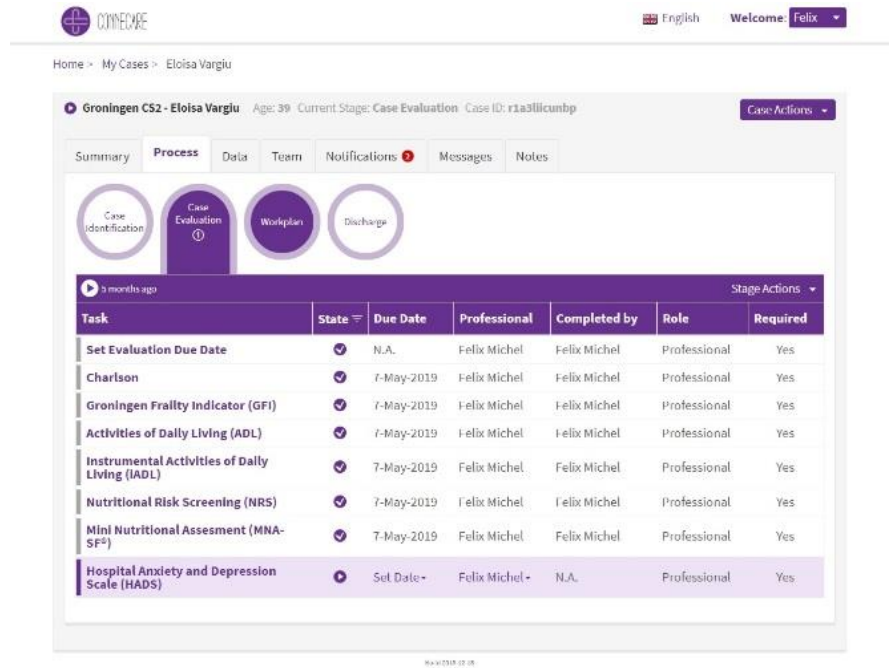


Figure 13 and Figure 14). The information describing the case and its associated tasks is received from the SACM.

When navigating to this page a Professional is shown the current stage of the case and the tasks associated with that stage:

- Completed tasks are shown with a check mark
- Active tasks for the Professional are highlighted and shown with a '▶' symbol
- Pending tasks which are not yet active are shown with a '■'

A professional can click on a task in this view to navigate into it.

A Professional is also able to click on any other stage to review the tasks associated with it. Completed stages will allow a Professional to review the data from the tasks in that stage. Future stages allow the Professional to see upcoming tasks which are not yet active.

Any actions configured for the stage are provided under the Stage Actions button.



Home > My Cases > Eloisa Vargiu

Groningen CS2 - Eloisa Vargiu Age: 39 Current Stage: Case Evaluation Case ID: r1a3lllcumbp

Summary Process Data Team Notifications Messages Notes

Case Identification Case Evaluation Workplan Discharge

3 months ago

Task	State	Due Date	Professional	Completed by	Role	Required
Set Evaluation Due Date	✓	N.A.	Felix Michel	Felix Michel	Professional	Yes
Charlson	✓	7-May-2019	Felix Michel	Felix Michel	Professional	Yes
Groningen Frailty Indicator (GFI)	✓	7-May-2019	Felix Michel	Felix Michel	Professional	Yes
Activities of Daily Living (ADL)	✓	7-May-2019	Felix Michel	Felix Michel	Professional	Yes
Instrumental Activities of Daily Living (IADL)	✓	7-May-2019	Felix Michel	Felix Michel	Professional	Yes
Nutritional Risk Screening (NRS)	✓	7-May-2019	Felix Michel	Felix Michel	Professional	Yes
Mini Nutritional Assessment (MNA-SF)	✓	7-May-2019	Felix Michel	Felix Michel	Professional	Yes
Hospital Anxiety and Depression Scale (HADS)	⊕	Set Date	Felix Michel	N.A.	Professional	Yes

Figure 13 - Example of a process: Case Evaluation for Case Study 2 in Groningen.

Home > My Cases > Eloisa Vargiu

Groningen CS2 - Eloisa Vargiu Age: 39 Current Stage: Workplan Case ID: r1a3lllcumbp

Summary Process Data Team Notifications Messages Notes

Case Identification Case Evaluation Workplan Discharge

3 months ago

Task	State	Due Date	Professional	Completed by	Role	Stage Actions
Physical Activity	✓	N.A.	Felix Michel	Felix Michel	Professic	Terminate stage Complete stage
Physical Activity	⊕	Set Date	Felix Michel	N.A.	Professic	Add Task
Patient Questionaire	⊕	Set Date	Felix Michel	N.A.	Professional	No

ADD TASK

Figure 14 - Example of a process: Workplan for Case Study 2 in Groningen.



## 2.7 Case Tasks

Case tasks are displayed for all cases on the dashboard and for a specific case in the case process tab (see

The screenshot shows the 'Physical Activity' task form in the CONNECARE system. The form is titled 'Physical Activity' and is associated with the patient 'Elosa Vargiu' and clinician 'Felix Michel'. The form includes the following fields and options:

- Clinician:** Felix Michel
- Role:** Professional
- Due Date:** Set Date-
- State:** Waiting for clinician input (with an 'Available' checkbox)
- Start date:** dd/mm/yyyy
- End date:** dd/mm/yyyy
- Number of steps daily:** 10000
- Minutes of low level activity daily:** 60
- Minutes of medium level activity daily:** 40
- Minutes of high level activity daily:** 20
- Max minutes without activity allowed daily:** 240
- Measurement:** Pending...

The form also features a 'Process' tab with a flow diagram showing the task's progress. At the bottom, there are three buttons: 'CLEAR', 'COMPLETE', and 'TERMINATE'.

Figure 15 and Figure 16). The case tasks are displayed from the data received from the SACM. They can be saved, completed or terminated. When a task is completed the data is returned to the SACM.

Once completed it is possible to update a tasks by choosing the Correct button.

This screenshot is identical to the one in Figure 15, showing the 'Physical Activity' task form for 'Elosa Vargiu' with the same fields and buttons.



Figure 15 - Example of tasks – Prescription of physical activity.

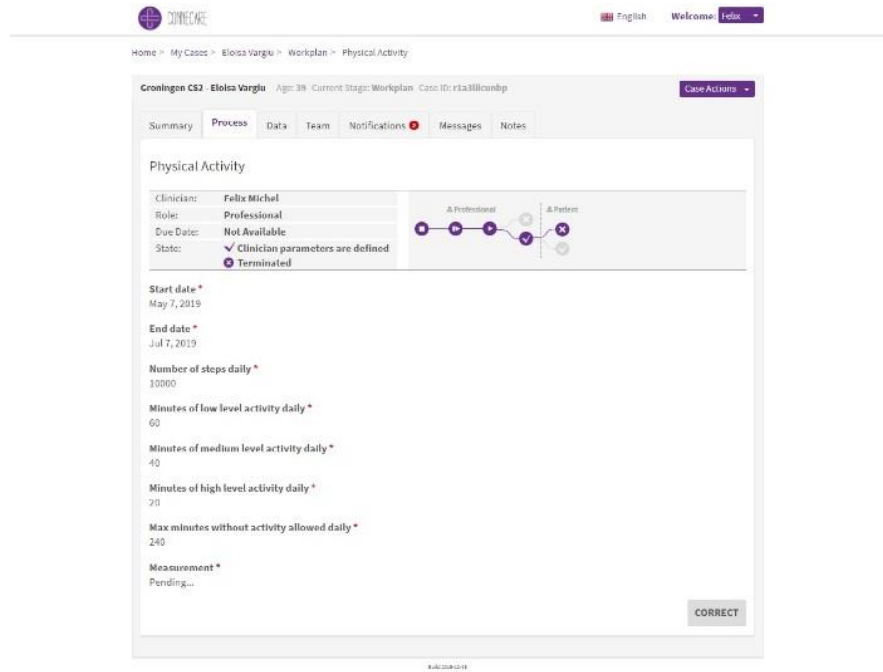


Figure 16 - Example of task: prescription of physical activity (filled).

## 2.8 Case Data

A summary of all the case data is provided in the case data tab (Figure 17).

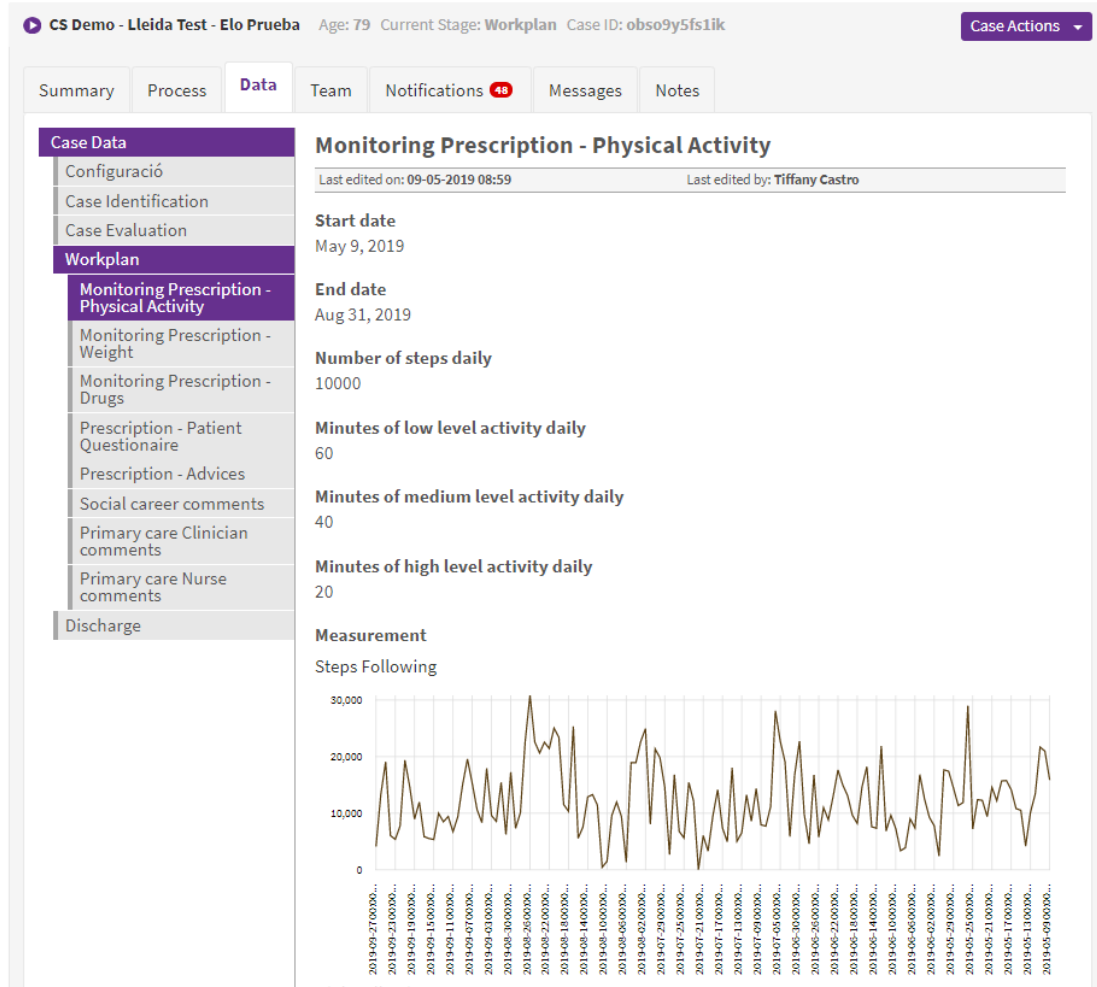


Figure 17 - Case Data

## 2.9 Case Team

A summary of the team and their roles assigned to a case is provided in the case team tab (see Figure 18). The access level of the team members can be changed. Team members can be added and removed from the case.



**Groningen CS2 - Eloisa Vargiu** Age: 39 Current Stage: Case Evaluation Case ID: r1a3liicunbp Case Actions

Summary Process Data **Team** Notifications 2 Messages Notes

**Members**

Name	# Open Tasks	Access-Level
Administrators (inherited)	0	READ WRITE CASE OWNER
Felix Michel (felix.michel@tum.de)	3	READ WRITE CASE OWNER

**Roles**

Name	Assigned User	# Open Tasks
Clinician	Felix Michel (felix.michel@tum.de)	3

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Figure 18 - The team.

## 2.10 Notifications

The SACM provides alerts from the SMS system. These are displayed for all cases on the dashboard and for a specific case on the case notifications tab (see Figure 19). The Professional can dismiss them once they have been seen.

Links to the notifications are provided on the dashboard to navigate directly to this page (see Figure 4 and Figure 5).

**Groningen CS2 - Eloisa Vargiu** Age: 39 Current Stage: Case Evaluation Case ID: r1a3liicunbp Case Actions

Summary Process Data Team **Notifications 2** Messages Notes

**Not acknowledged notifications** Actions

Site of Surgery Felix Michel corrected the task parameters "Sites of Surgery" manually.	Mo 13.05	X
Site of Surgery Felix Michel corrected the task parameters "Sites of Surgery" manually.	Tu 01.10	X

**Acknowledged notifications**

Empty

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Figure 19 - Example of notifications.



## 2.11 Case Messages

Messages between Professionals on the clinical team and between Professional and Patient are supported (

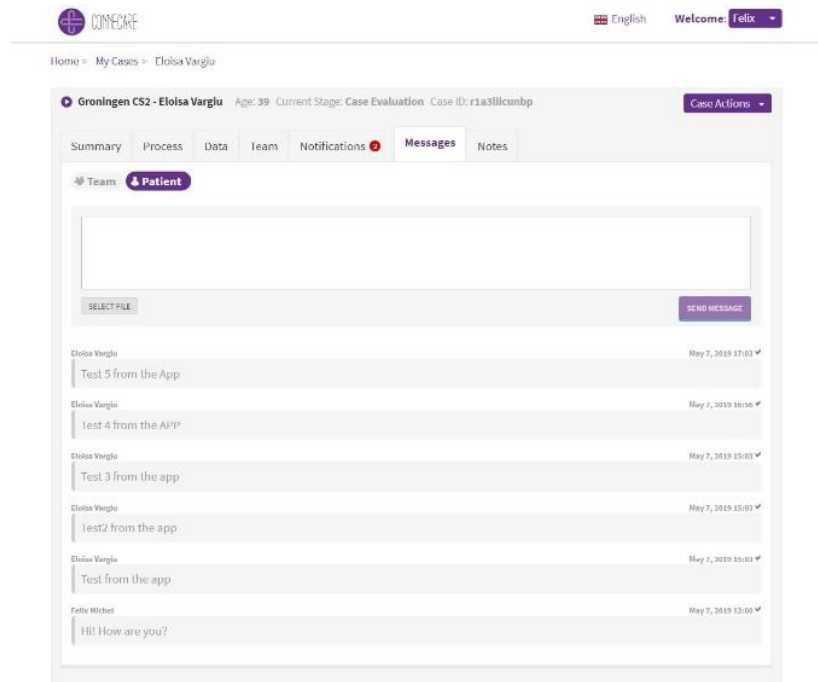


Figure 20 and Figure 21). Professional to Professional messages are supported through the SACM APIs. Professional to Patient messages are supported by SMS APIs.

Once a message has been seen it is marked as read. Read messages remain on the page.

New messages can be sent to other clinicians associated with the case and to the patient SMS app.

Links to the messages are provided on the dashboard to navigate directly to this page.

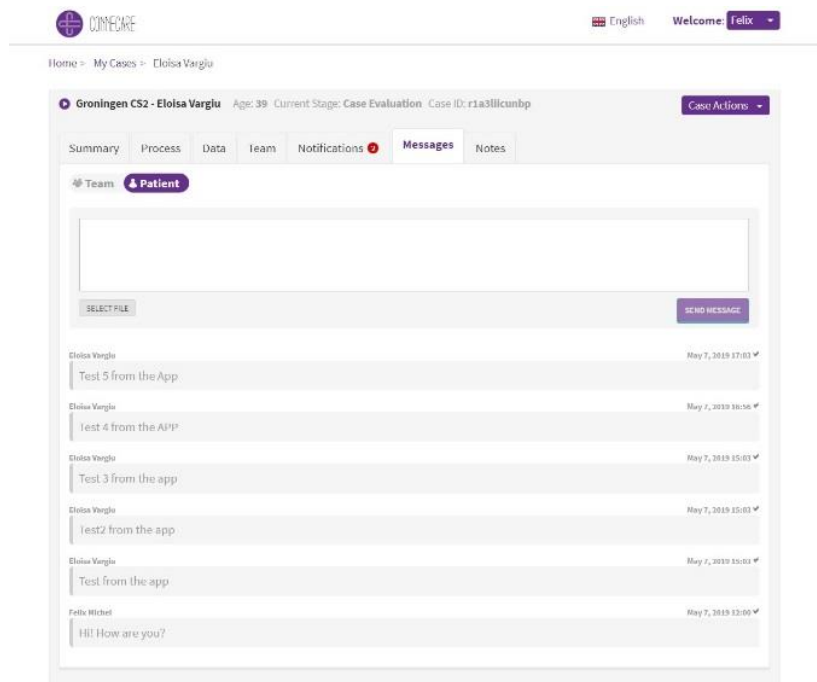


Figure 20 - Example of message exchange among the professionals and the patient.

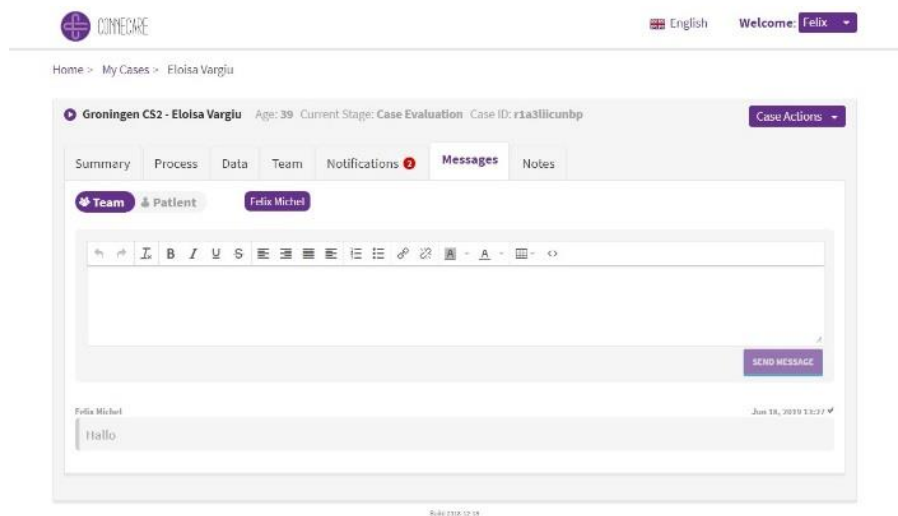


Figure 21 - Example of message exchange among professionals (the team).

## 2.12 Case Notes

General notes associated with a case are displayed on the case notes page.

Existing notes can be edited and new notes can be added. See Figure 22, Figure 23, and Figure 24.





Home > My Cases > Eloisa Vargiu

**Groningen CS2 - Eloisa Vargiu** Age: 39 Current Stage: Case Evaluation Case ID: r1a3liicunbp Case Actions

Summary Process Data Team Notifications 2 Messages **Notes**

rwrwerwr

Last edited by Felix Michel 4 months ago EDIT

Build 2018-12-18

Figure 22 - Editing of a note.

Home > My Cases > Example Example

**Groningen CS2 - Example Example** Age: 20 Current Stage: Workplan Case ID: sidpe4epj7z3 Case Actions

Summary Process Data Team Notifications 30 Messages **Notes**

No Notes yet.

Last edited by Felix Michel 3 months ago ADD

Build 2018-12-18

Figure 23 - Adding a note.

Home > My Cases > Example Example

**Groningen CS2 - Example Example** Age: 20 Current Stage: Workplan Case ID: sidpe4epj7z3 Case Actions

Summary Process Data Team Notifications 30 Messages **Notes**

Undo Redo Text **B** *I* U Link Image Table Code Color Background Color Table Code

SAVE DISCARD

Build 2018-12-18

Figure 24 - Saving a note.



Also in this case, requirements from the 4 sites were different. Thus, in Lleida they asked for a different interface, thought as a “wall” in which the different professionals may leave a note, according to their role. The corresponding interface is given in Figure 25.

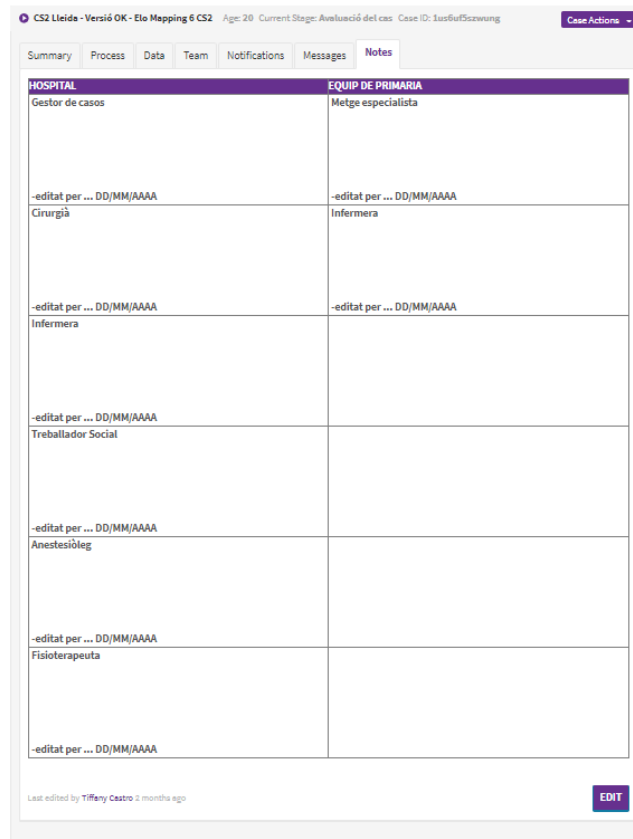


Figure 25 - Notes in the case of Lleida.



### 3. The Integrated Clinical Decision Support System

The Mapping DSS is a software tool providing a global view of the cases (hence, patients) pertaining to a given clinician with the goal of facilitating (i) monitoring of patients' conditions and (ii) focussing on patients with specific conditions. The global view is based on a map, rendering patients as markers geolocalised according to their dwelling address as registered in the SACM. *Rendering* of patient markers is based on selected conditions of the case, such as scores of risk assessment questionnaires manually input by the professionals through the SACM, or barriers to treatment. *Filters* are available to enable the clinician to focus on selected conditions and render patient markers accordingly.

#### 3.1 Overview of functionalities

The Mapping DSS is accessible to professionals through a dedicated button on the right side of the SACM dashboard ("Go To Mapping"), as depicted in Figure 5.

The DSS mapping window is organised in 5 areas, as emphasised in Figure 26 (red boxes and letters added to help understanding following description):

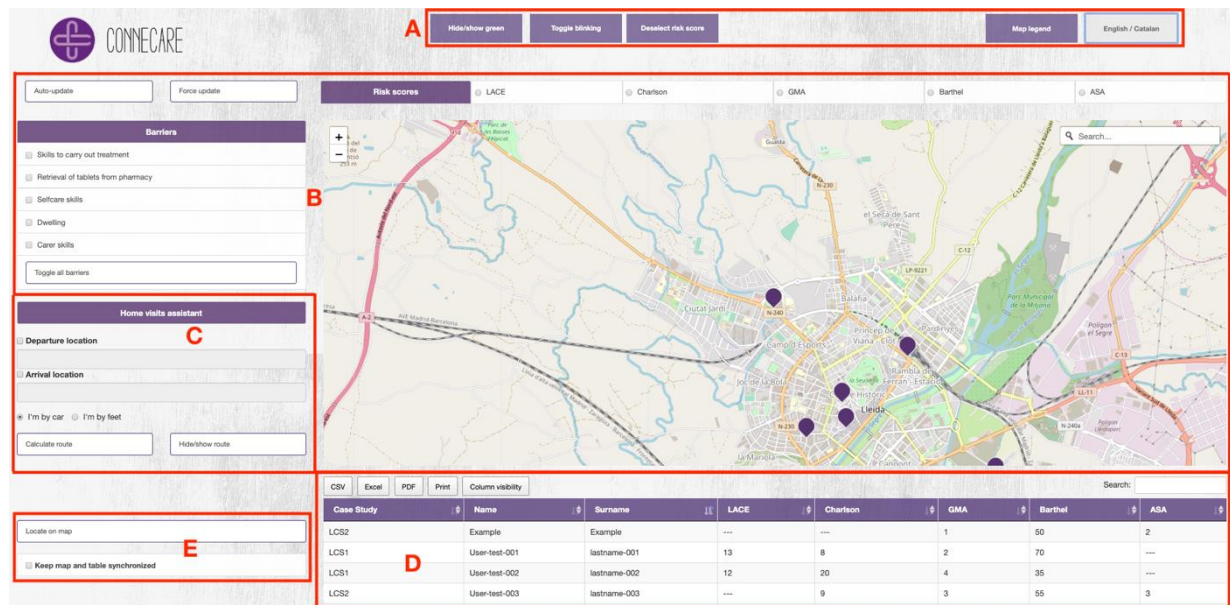


Figure 26 – The 5 functional areas of the Mapping DSS screen.

1. The topmost area (A) provides two sets of buttons: the three on the left provide for configurations of the rendering and filtering of the markers, whereas the two on the left provide utility functions (e.g. English / Catalan translation)
2. The central area (B) is the largest one as it provides the core functionality of the Mapping DSS: localisation of patient on an interactive map as clickable markers rendered according to the selected clinical criteria (Figure 27). The map itself is interactive in a number of ways, basically



what you would do in systems such as Google Maps. Most importantly, clicking on markers shows a popover decorated with the patient dwelling address (as registered in the SACM), a “Go to summary” button enabling quick jump to the summary screen of the selected patient in the SACM (depicted in Figure 28), and a clickable text about whether the patient has pending messages or alerts enabling quick jump to the appropriate SACM screen (more details are given in D3.4).

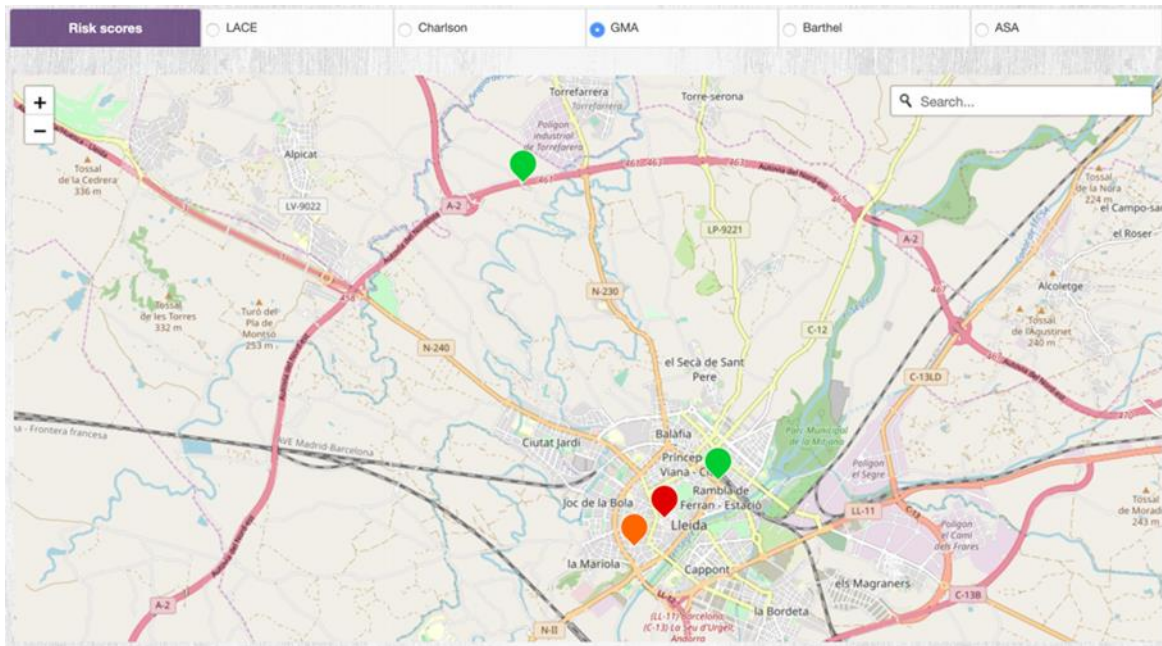


Figure 27 - Rendering of patients' severity according to the GMA stratification score.

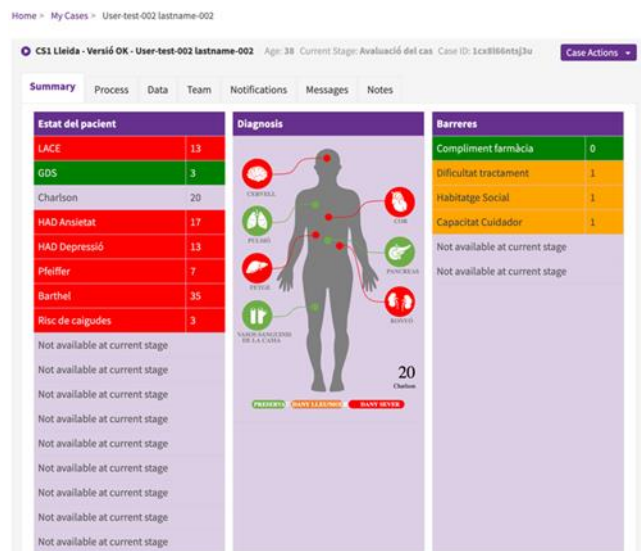
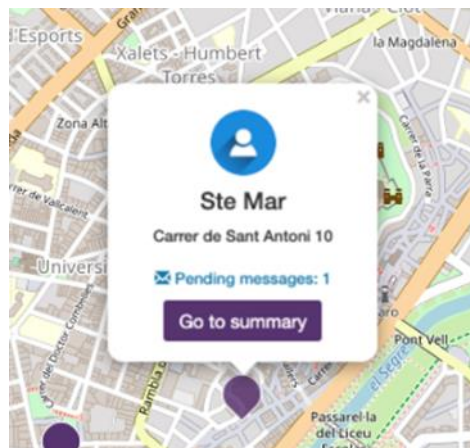


Figure 28 - A popover (left) showing basic information and quick links to relevant SACM screens such as the summary (right).

- The area complementing the central part (C) is meant to assist clinicians in planning home visits: by selecting a set of patients from the table view and then clicking on button “Calculate route”, a driving route visiting all the patients is displayed, and navigation instructions appear on a dedicated popover window right below the search box, as depicted in Figure 29.

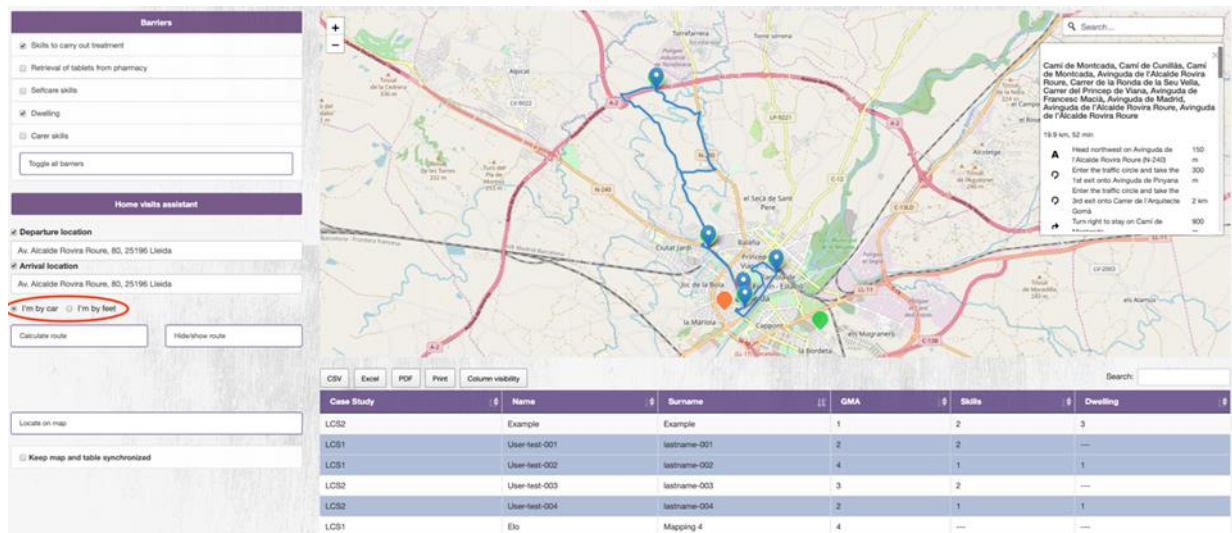


Figure 29 - Routing information for planning home visits (circled in red is driving/walking choice).

- The bottom area (D), is dedicated to the table view, also delivering export (e.g. CSV, MS Excel, PDF) and printing functionalities.
- The bottom left area (E) provides functionalities ensuring synchronisation between the map view and the table view, that have been added to the original requirements in an effort to improve clarity of the user interface and configuration options.

### 3.2 Integration with SACM

The Mapping DSS is deeply integrated with the SACM as regards both the front-end and the back-end. For the frontend, four are the integration points, one going from the SACM to the Mapping DSS and three going the other way. The former is the “Go To Mapping” button shown in Figure 5, enabling users to open the Mapping DSS screen in the first place. The latter three are (a) the “Go to summary” button in each patient popover, which opens the SACM summary page for the selected patient, (b) the “Pending messages” clickable text, which opens the SACM messages screen (Figure 30), and (c) the “Pending alerts” clickable text, which opens the SACM notifications screen (Figure 31).



Home > My Cases > Ste Mar

CS2 Lleida - Versió OK - Ste Mar Age: 32 Current Stage: Avaluació del cas Case ID: 1nm6tdhgzczs Case Actions

Summary Process Data Team Notifications Messages Notes

Team Patient

SELECT FILE SEND MESSAGE

Ste Mar Sep 16, 2019 10:15  
Hey doctor, here patient, wazzup?

Figure 30 The messages screen in the SACM, directly connected to the Mapping DSS screen.

Home > My Cases > Elo Mapping 4

CS1 Lleida - Versió OK - Elo Mapping 4 Age: 20 Current Stage: Avaluació del cas Case ID: tm2c0m202opm

Summary Process Data Team Notifications 2 Messages Notes

Not acknowledged notifications Actions

Prescripció de la monitorització - Pressió arterial sistòlica\diastòlica X  
La mesura presa està fora de rang.La mesura és inferior al valor mínim prescrit Fr 06.09

Prescripció de la monitorització - Pressió arterial sistòlica\diastòlica X  
La mesura presa està fora de rang.La mesura és inferior al valor mínim prescrit Fr 06.09

Acknowledged notifications

Empty

Figure 31 The notifications screen in the SACM, directly connected to the Mapping DSS screen.

As for the backend, integration happens because all the data used by the Mapping DSS is fetched by itself from the SACM backend, hence the two sub-systems always show a consistent view of patients' information.

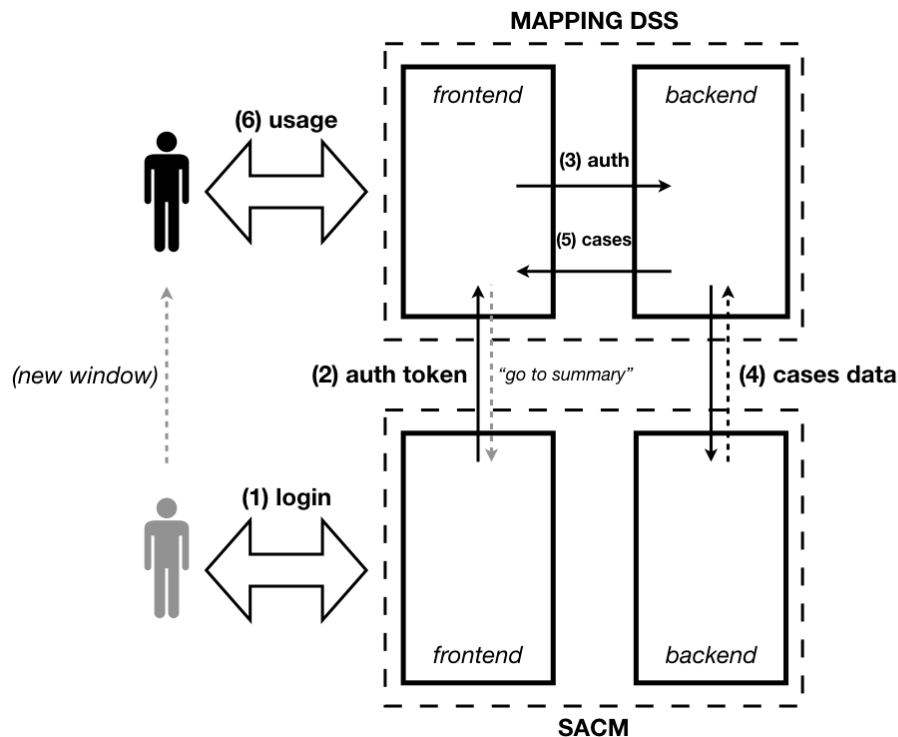


Figure 32 Interactions supporting Mapping DSS – SACM integration

In particular, the flow of interactions among the sub-systems is depicted in Figure 32 (also reported in D3.4):

1. When the user clicks on the “Go To Mapping” button the SACM frontend passes the authentication token to the Mapping DSS frontend by appending it to its URL
2. The Mapping DSS frontend then, in turn, forwards the token to its backend, which stores it for later usage (namely, inclusion as “Authorisation” header in all HTTPS requests to the SACM backend). In the meanwhile, the Mapping DSS frontend also asks to the Mapping DSS backend the data it needs to operate (namely, the list of cases for the logged user, there including data about patient of the case and its risk scores and barriers)
3. At this point, the Mapping DSS backend starts a round of interaction with the SACM backend – periodically repeated to stay up-to-date with respect to, for instance, insertion of new patients or completion of pending risk scores / barriers questionnaires – that encompasses the following steps:
  - a. Fetch the list of all the cases ID associated to the authentication token of the currently logged clinician (this ensure access control, thus privacy)
  - b. For each case ID, fetch the list of pending messages and alerts



- c. For each case ID, fetch the list of scores and barriers, provided that they have an associated value (namely, that the corresponding questionnaires / measurements have been completed)
    - d. For each score / barrier, fetch its value
  4. The Mapping DSS backend replies to its frontend as soon as the required data has been acquired from the SACM backend, and then either waits for new connections (new users logging in) or for the update interval timer to trigger a check for updates

Finally, the Mapping DSS frontend displays the data acquired by its backend to the logged clinician, which may then start interacting with the UI.





## 4. Deployment Environment

The SACM uses a modern, containerized deployment approach based on Docker. Each sub-system is containerized in a separate container. The current version of the SACM is split into six different containers that are orchestrated using Docker compose. The maintenance of the containers is done via Docker hub and a Docker compose file.

### 4.1 SACM SocioCortex

The main container that runs SocioCortex. Especially for the CONNECARE project, SocioCortex was adapted that it is fully compatible with Docker and other containerized solutions.

### 4.2 SACM API

The SACM API is a lightweight NodeJS-based wrapper around the SocioCortex API. It provides developers a secure and convenient way to interact with the SocioCortex system. Additionally, it provides specific API endpoints that are tailored to the CONNECARE use case.

### 4.3 SACM MySQL

The SACM uses MySQL as a proven and production-ready relational database to store model, case, and questionnaire information. This container is protected within the Docker network, configuration, and firewalls to be only accessible from within the SocioCortex container. This container uses a linked local volume to store the data on the filesystem of the server.

### 4.4 SACM MongoDB

The SACM uses a MongoDB document store to collect log data. The logging functionality can easily be turned on, e.g., for debugging or analytical use cases, and off, e.g., for privacy reasons, completely. This container uses a linked local volume to store the data on the filesystem of the server.

### 4.5 SACM Client

The SACM client container runs an internal web server to serve the client web application for the SACM provided by ADI.

### 4.6 SACM DSS

The DSS container runs the mapping decision support system provided by UNIMORE. The container exchanges data with the SACM API container via its REST API.



## 5. Implementation Work Carried Out after the Study Release

In the following we briefly highlight some technical extensions and adaptations accomplished from the Study Release to the Final Release, mostly of them coming from the requirements of the clinicians during the implementation studies.

### 5.1 New Requirements

***Extended SocioCortex to support case team management, this implies case-based read- and write access rights and the ability to change the case roles dynamically.***

The page for managing the team in charge of a case has been created (see Figure 18). Through it, any clinician may assign right (read, write, read-and-write) to each of the clinicians in charge of that case. Roles of the involved clinicians may be also changed.

***Extended SocioCortex to support showing the generated linked-data structure of a case with a hierarchical representation.***

The page for summarizing all the data structure of a case, showing the status of each step of the process, as well as all the tasks. An example is given in Figure 17.

***Simplified the third party integration with a new task type, named DualTask that support a human interaction followed by an automated execution.***

This concept is used for all integration tasks. For example, in case a clinician defines a prescription that is then executed by the patient via a mobile application.

***Extend the SocioCortex to support correcting tasks at any time even after task completion. This feature allows clinicians to correct occurring mistakes during the task completion.***

One of the requirements asked for the clinicians as mandatory to may start the implementation studies was to may correct an already filled questionnaire/form. In fact, without this possibility, the clinicians that had to make a change because of an error in filling it had to cancel the erroneous form and to create a new one. It is easy to note that in real clinical practice this behavior is not acceptable and may cause several problems. Thus, the SACM has been improved to allow correcting/changing forms/questionnaires. Figure 33 and Figure 34 show the corresponding interface.

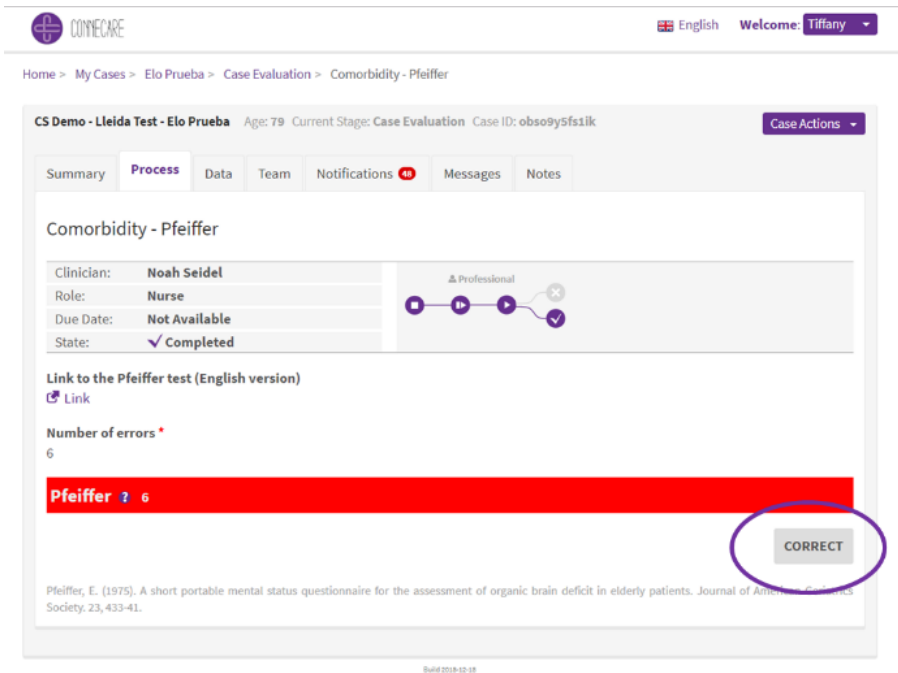


Figure 33 - Possibility to correct an already filled form/questionnaire.

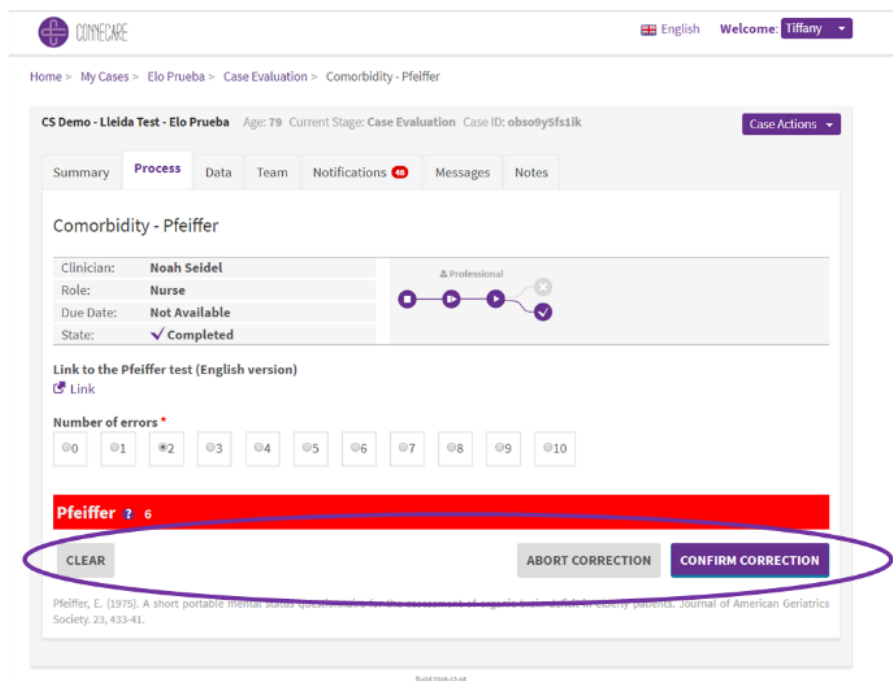


Figure 34 - Possibility to correct an already filled form/questionnaire: confirmation of a change.

**Workplan tasks can be added multiple times and even executed parallel. In such situations the task names are not unique anymore, therefore, SocioCortex was extended to support dynamic tasks titles based on the selected task content.**



See Figure 35 and Figure 36 below.

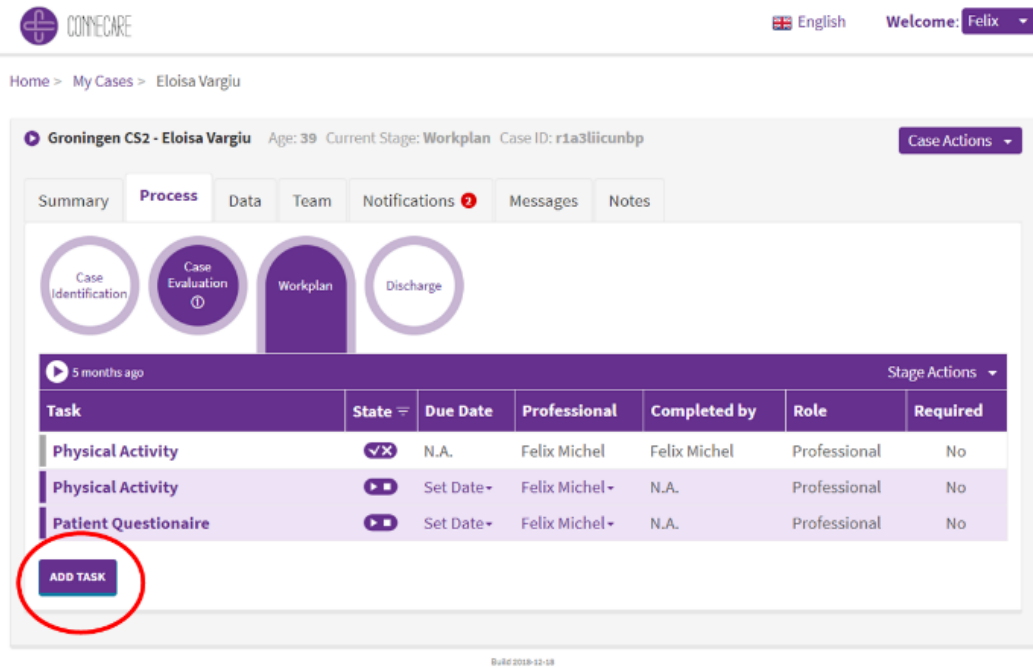


Figure 35 - Addition of a new task to the workplan.

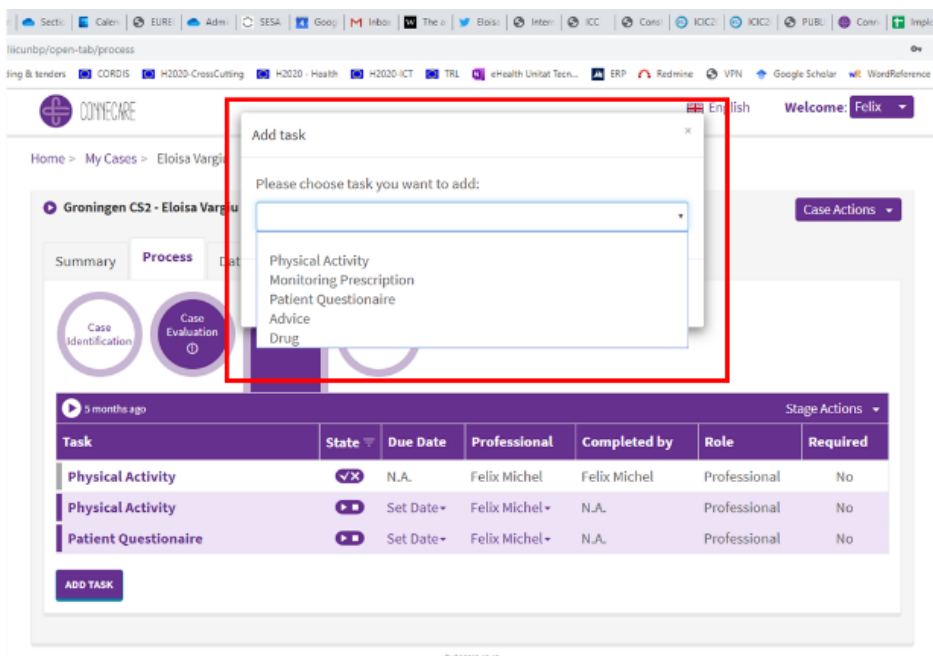


Figure 36 - Addition of a new task to the workplan: available tasks in CS2 in Groningen.

**Defined modelling capabilities to support auto-check questionnaires.**



The XML used for modelling has been improved to allow the definition of auto-check questionnaires. The overall list of questionnaires currently implemented is reported in the deliverable D4.3 “Advanced monitoring tools”. The communication between the SACM and the SMS to handle with those questionnaire has been also implemented.

***Extended SocioCortex to support exporting case instances for scientific data analytics and evaluation.***

This functionality allows exporting the data from the SACM in order to be analyzed by the clinical partners in WP6 and WP7. Results in each sites have been reported in D6.2 “Results from Case Study 1”, D6.3 “Results from Case Study 2”, and D6.4 “Results from Case Study 3”.

***Improved the performance of SocioCortex where needed.***

The creation of a new case and changing a task owner could take very long due to the assignment of related access rights to each object. Therefore, SocioCortex uses internally an optimized representation.

## 5.2 Case Definition

As pointed out also in the majority of the deliverables, in CONNECARE each case study in each site has been modelled in a different way. Thus, summarizing:

- 4 sites;
- 2 Case Studies in each, 3 in Barcelona
  - CS1 Community-based prevention of unplanned hospital-related events in frail complex patients with high risk for hospitalization
  - CS2 Preventive patient-centred intervention in CCPs undergoing elective major surgery
  - CS3 Prehabilitation program
- 9 different processes;
- 9 different models in the SACM.

In the following the common forms and questionnaires adopted in each site are listed<sup>1</sup>:

- Inclusion / Assign patient (in each site and in each case study personalized depending on the kind and the number of involved professionals in a team)
- Technological capability
- Inform consent (with the link to download the document to be signed)

---

<sup>1</sup> For standard questionnaires covered by copyright an authorization has been asked and displayed in the corresponding page. For standard questionnaires published in the literature, the corresponding reference has been provided.



- Charlson

The customization of each site in terms of forms and questionnaires are reported below:

- Lleida / Barcelona
  - GDS
  - GMA (Barcelona only Case Study 1)
  - Pfeiffer (Barcelona only Case Study 1)
  - HAD (Barcelona only Case Study 1)
  - Treatment adherence and capability to follow it (Barcelona only Case Study 1)
  - Carer's capability (Barcelona only Case Study 1)
- Lleida / UMCG
  - ASA (Lleida only Case Study 2)
  - Daily life activities (Lleida Case Study 1, UMCG Case Study 2)
- Lleida / ASSUTA
  - LACE (only Case Study 1)
  - Barthel
  - Sleeping quality
  - Communication capability
  - Downton Fall Index
  - Smoking and alcohol
  - SF-12
  - Medication adherence
  - Dwelling status
- UMCG / ASSUTA
  - Demographics data
  - Medical information
- Lleida
  - Complexity-risk test (only Case Study 2)
  - Problem with using money (only Case Study 2)
  - Nutrition /proteins (only Case Study 2)
  - WOMAC (only Case Study 2)
  - EQND (only Case Study 2)
  - S-LANSS (only Case Study 2)
  - Self-management capability, chirurgical patient (only Case Study 2)
- UMCG
  - CCQ
  - ACQ



- Spirometry
- Previous exacerbations
- Conclusion
- Site of surgery (only Case Study 2)
- Groningen Frailty Indicator (only Case Study 2)
- Nutritional Risk Assessment (only Case Study 2)
- Mini Nutritional Assessment (only Case Study 2)
- HADS
- ASSUTA
  - Inclusion criteria
  - Nutrition
  - Lawton
  - HADS
  - EQ5D
  - Sweet16
  - MUST
  - Hospital release plan
  - Medical assessment by the Department of Surgery or Anesthesiologists (only Case Study 2)
  - Initial data (only Case Study 2)
  - Time up and go (only Case Study 2)
  - 6MWT (only Case Study 2)
  - 30s STS (only Case Study 2)

Finally, the following improvements have been done:

- The project consortium noticed that the modelling is a continuous process that cannot be done centralized by one partner if we want to use the benefit of the modelling approach and apply changes in an agile way. Therefore, after the initial models are defined, we guided local technical partners to adapt the models continuously in cooperation with the clinical professionals.
- Enhanced the upload of new models to be more fault tolerant. New models can be uploaded without interruption of the productive system.
- Extended the models with new modelling capabilities, such as modelling patient questionnaires, advices, drug prescriptions, and modelling graphical summary elements with scalable vector graphics.

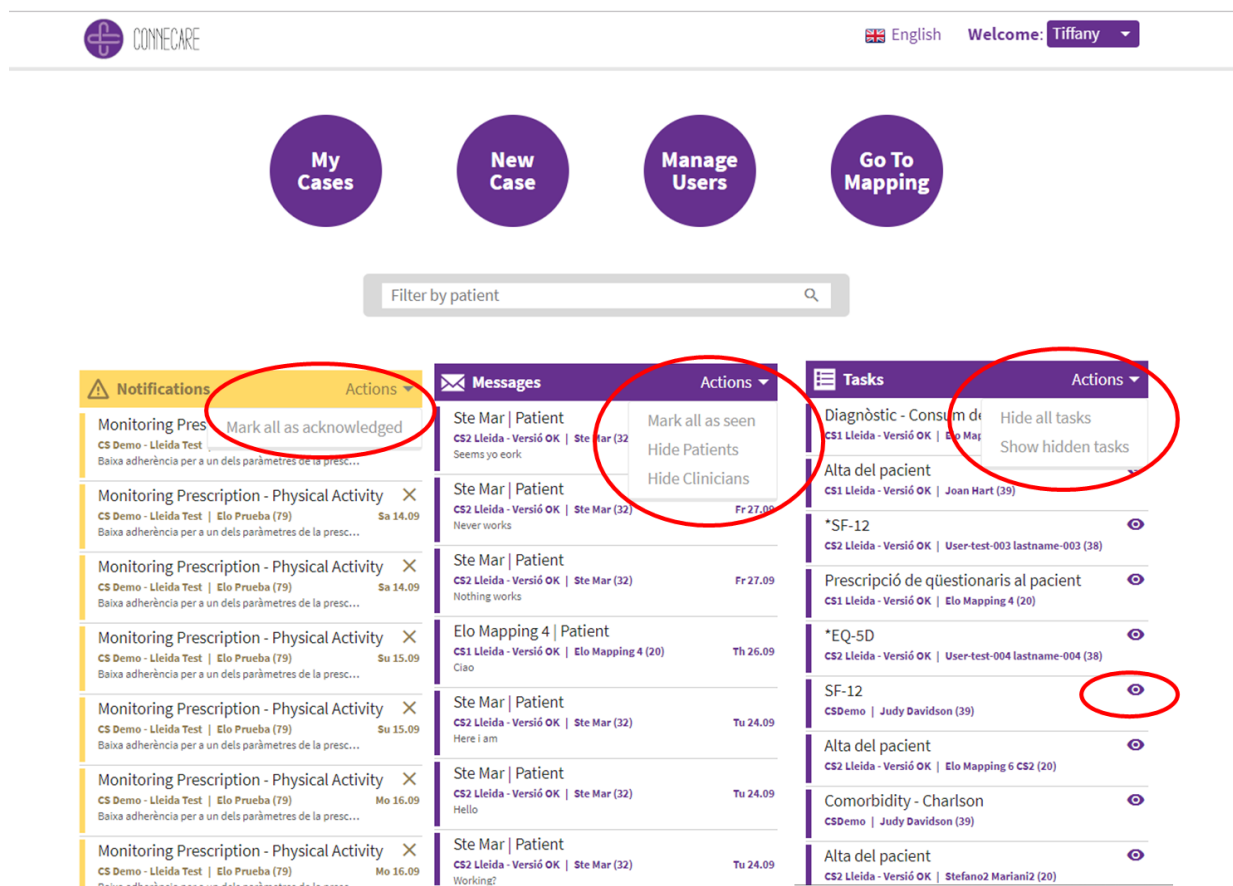
### 5.3 Usability Improvements

Based on the conceptual design, TUM provided all over the project many high-fidelity mock-ups for the frontend implementation.

Below the main improvements in terms of usability required during the implementation studies are reported.

**Enhanced the dashboard usability by providing a feature to clean all notifications. Messages can be filtered by patient or by team and all the messages may be marked as read. Additionally, pending tasks can be hidden and unhidden on the dashboard. Overdue tasks are highlighted.**

See Figure 37 below.



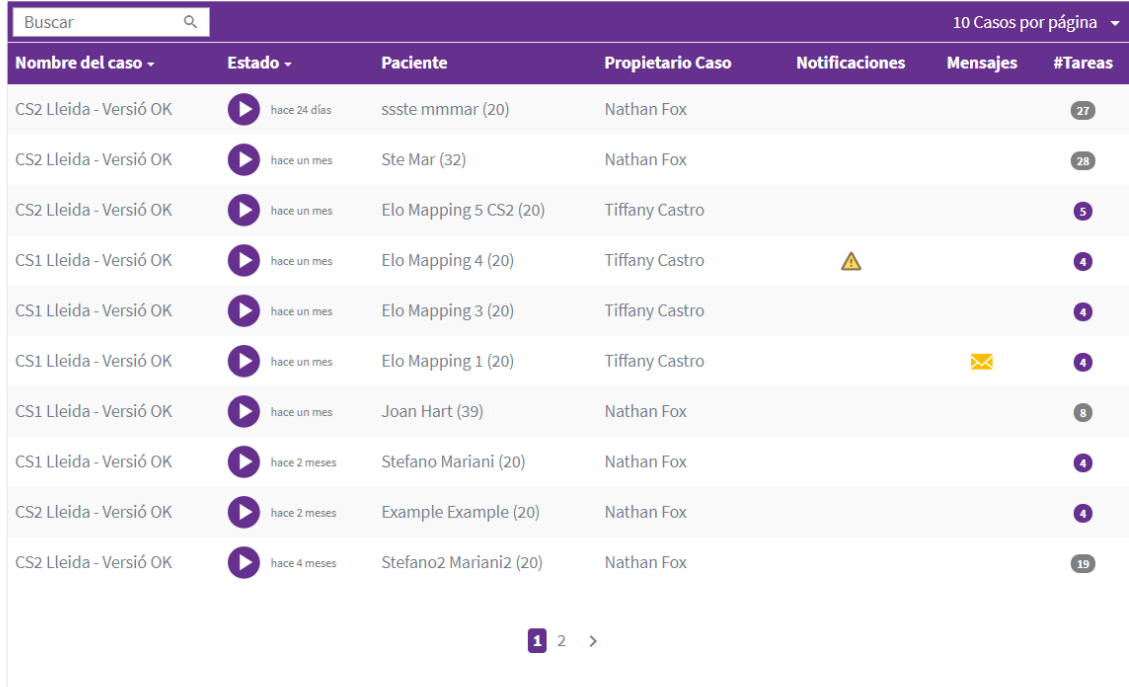
The screenshot shows the CONNECARE dashboard interface. At the top, there is a header with the CONNECARE logo, a language selector set to 'English', and a welcome message for 'Tiffany'. Below the header are four main navigation buttons: 'My Cases', 'New Case', 'Manage Users', and 'Go To Mapping'. A search bar labeled 'Filter by patient' is positioned below the navigation buttons. The main content area is divided into three columns: 'Notifications', 'Messages', and 'Tasks'. Each column has an 'Actions' dropdown menu. In the 'Notifications' column, the 'Mark all as acknowledged' option is highlighted. In the 'Messages' column, the 'Mark all as seen', 'Hide Patients', and 'Hide Clinicians' options are highlighted. In the 'Tasks' column, the 'Hide all tasks' and 'Show hidden tasks' options are highlighted. Additionally, a red circle highlights a task with a status indicator (a small circle with a dot) next to it.

Figure 37 - Filtering extra functionalities in the dashboard.

**Enhanced the My Case page by providing counters for the number of unread messages per case, the number of not acknowledged notifications and the number of pending tasks. Additionally, a pagination option is added.**



See Figure 38 below.



Nombre del caso	Estado	Paciente	Propietario Caso	Notificaciones	Mensajes	#Tareas
CS2 Lleida - Versió OK	▶ hace 24 días	ssste mmmar (20)	Nathan Fox			27
CS2 Lleida - Versió OK	▶ hace un mes	Ste Mar (32)	Nathan Fox			28
CS2 Lleida - Versió OK	▶ hace un mes	Elo Mapping 5 CS2 (20)	Tiffany Castro			5
CS1 Lleida - Versió OK	▶ hace un mes	Elo Mapping 4 (20)	Tiffany Castro	⚠		4
CS1 Lleida - Versió OK	▶ hace un mes	Elo Mapping 3 (20)	Tiffany Castro			4
CS1 Lleida - Versió OK	▶ hace un mes	Elo Mapping 1 (20)	Tiffany Castro		✉	4
CS1 Lleida - Versió OK	▶ hace un mes	Joan Hart (39)	Nathan Fox			8
CS1 Lleida - Versió OK	▶ hace 2 meses	Stefano Mariani (20)	Nathan Fox			4
CS2 Lleida - Versió OK	▶ hace 2 meses	Example Example (20)	Nathan Fox			4
CS2 Lleida - Versió OK	▶ hace 4 meses	Stefano2 Mariani2 (20)	Nathan Fox			19

Figure 38 - Notifications, messages, and number of pending tasks in the My Cases page.

**Enhanced the usability of the summary page by providing a link to the related task.**

In this way, the summary page may be used as a complete dashboard of a case giving direct access to the main tasks, in addition to give a graphical view of the overall case.

**During the Implementation studies, the need for colored thresholds arose.**

To support also simple frontend based models, a new model element named *uiReference* was introduced to provided hints for the frontend rendering. Figure 39 sketches an example of use of the *uiReference* from the Case Study 2 in Lleida, linked to the Pfeiffer questionnaire. Figure 40 shows how the XML is translated in the front-end.

```
expression='number(pfeiffer1,0)'
additionalDescription="Si >= 3 Sospita de deteriorament cognitiu (Vermell)|| Si <= 2 No hi ha deteriorament cognitiu (Verd)"
uiReference="colors(0<=green<3<=red<11<=orange<=10000)" />
```

Figure 39 - Example of *uiReference* in the case of the Pfeiffer.



Home > My Cases > Ste Mar > Avaluació del cas > Estat cognitiu/mental - Pfeiffer

CS2 Lleida - Versió OK - Ste Mar Age: 32 Current Stage: Avaluació del cas Case ID: 1nm6tdhgzcfs

Summary **Process** Data Team Notifications Messages **23** Notes

Estat cognitiu/mental - Pfeiffer

Clinician: **Noah Seidel**  
 Role: **Nurse**  
 Due Date: **Set Date**  
 State: **Active**

Enllaç al test de Pfeiffer (versió en castellà)  
 Link

Número de ... 4 ...

0 1 2 3 4 5 6 7 8 9 10

Pfeiffer ? 0

CLEAR COMPLETE TERMINATE

Pfeiffer, E. (1975). A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. Journal of American Geriatrics Society, 23, 433-41.

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Figure 40 - Graphical effect of the uiReference.

**Enhanced the functional query language with some mathematical functions such as round, floor, ceil and default values for non-numeric values to improve the modelling capabilities for clinical questionnaires.**

Figure 41 shows an example of the use of the “round” for calculating the BMI (example in Catalan, from the Case Study 2 in Lleida).

```
<DerivedAttributeDefinition id="AnthropometricGenollHomesIMC" type="number" multiplicity="exactlyOne" description="IMC Homes (P/D)"
  uiReference="colors (0<=green<=27<orange<30<=red<=10000)"
  additionalDescription="Home sobrepès si IMC > 27 i si lt;= 29 (Taronja) | Obesitat si IMC >= 30 (Vermell)"
  expression="round(AnWeighGenoll / (AnthropometricGenollHomes/100*AnthropometricGenollHomes/100), 2)"/>
```

Figure 41 - Example of the use of the mathematical function "round".

### 5.4 The Demo Tenant

For the sake of dissemination and exploitation, a fifth tenant has been added, called Demo. This tenant contains a case definition based on an ad-hoc model (fully in English) defined merging together features from all the Case Studies of CONNECARE. Thanks to it the CONNECARE system has been shown in its real environment (not the test one, as before) illustrating the overall set of functionalities (also those available only in one of the sites).



## 6. Outlook of Future Implementation Options

### 6.1 Suggestions for Improvement from the Implementation Log

As pointed out in WP2 and WP6 deliverables, during the study, clinicians reported bugs, technical and usability problems, and also requirements of changes in an Implementation Log file. This section summarizes the main issues still open due to time constraint and priorities.

#### 6.1.1 Grouping Patients in the Dashboard

In the dashboard, all the pending tasks are showed and listed according the timing. This list can be very long and, thus, difficult to manage (see Figure 42).

Tasks	Actions
Diagnòstic - Consum de tabac i alcohol CS1 Lleida - Versió OK   Elo Mapping 2 (20)	⊙
Alta del pacient CS1 Lleida - Versió OK   Joan Hart (39)	⊙
*SF-12 CS2 Lleida - Versió OK   User-test-003 lastname-003 (38)	⊙
Prescripció de qüestionaris al pacient CS1 Lleida - Versió OK   Elo Mapping 4 (20)	⊙
*EQ-5D CS2 Lleida - Versió OK   User-test-004 lastname-004 (38)	⊙
SF-12 CSDemo   Judy Davidson (39)	⊙
Alta del pacient CS2 Lleida - Versió OK   Elo Mapping 6 CS2 (20)	⊙
Comorbidity - Charlson CSDemo   Judy Davidson (39)	⊙
Alta del pacient CS2 Lleida - Versió OK   Stefano2 Mariani2 (20)	⊙
SF-12 CSDemo   Judy Davidson (39)	⊙
Estat comòrbid - Índex de comorbiditat d... CS1 Lleida - Versió OK   Joan Hart (39)	⊙
Discharge Form CSDemo   Judy Davidson (39)	⊙
*EQ-5D CS2 Lleida - Versió OK   Elo Mapping 6 CS2 (20)	⊙

Figure 42 - Example of list of tasks.

The new requirement consists on allowing grouping together the tasks corresponding to a given patient in order to focus, first, on the patient and, then, on the corresponding pending tasks.

#### 6.1.2 Notifications

Currently, the SMS sends the alerts as soon as they occur. Technically, it means that the check of the alert rule is done every time a new data comes into the system.

In the case of alerts related to the physical activity, aimed at signaling cases in which the prescribed physical activity has not be done, data come anytime the patient synchronizes the bracelet. In so doing,



professionals normally receive a lot of alerts all along the day that, actually, are not real alerts having the possibility that the patient will achieve her/his goal before the end of the day (see Figure 43).

Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción	Fr 04.10
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción advice1 comments	Th 03.10
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción	Th 03.10
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción	Th 03.10
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción advice1 comments	We 02.10
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción	We 02.10
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción	We 02.10
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción	Tu 01.10
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción advice1 comments	Mo 30.09
Monitoring Prescription - Physical Activity Baja adherencia para uno de los parámetros de la prescripción	Mo 30.09

Figure 43 - Example of duplicated notifications.

Professionals asked to change this functionality sending only one message at the beginning of the next day. This functionality is already running in the test environment but it is not uploaded in production because of the end of clinical studies.

Regarding the notifications already read (i.e., acknowledged), they also pointed out that it is not necessary to show the history. Figure 44 shows how the acknowledged notification are currently displayed.

Acknowledged notifications	
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció advice1 comments	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció advice1 comments	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago
Monitoring Prescription - Physical Activity Baixa adherència per a un dels paràmetres de la prescripció	Acknowledged by Nathan Fox a month ago

Figure 44 - Example of acknowledged notifications.



### 6.1.3 Summary Page

Clinicians in Lleida asked for an improvement in the summary page to add a visual information also regarding the monitored activities, linked to the tasks prescribed in the workplan. The suggestion consists of adding a place in the summary with the prescribed tasks, colored according to their status, according to what has been prescribed: green if in the given range of values, yellow if it overpasses the given range but still in a “normal” range, and red if it overpasses the range and generates an alarm. Figure 45 shows an example mock-up of how it may be shown in the summary page.

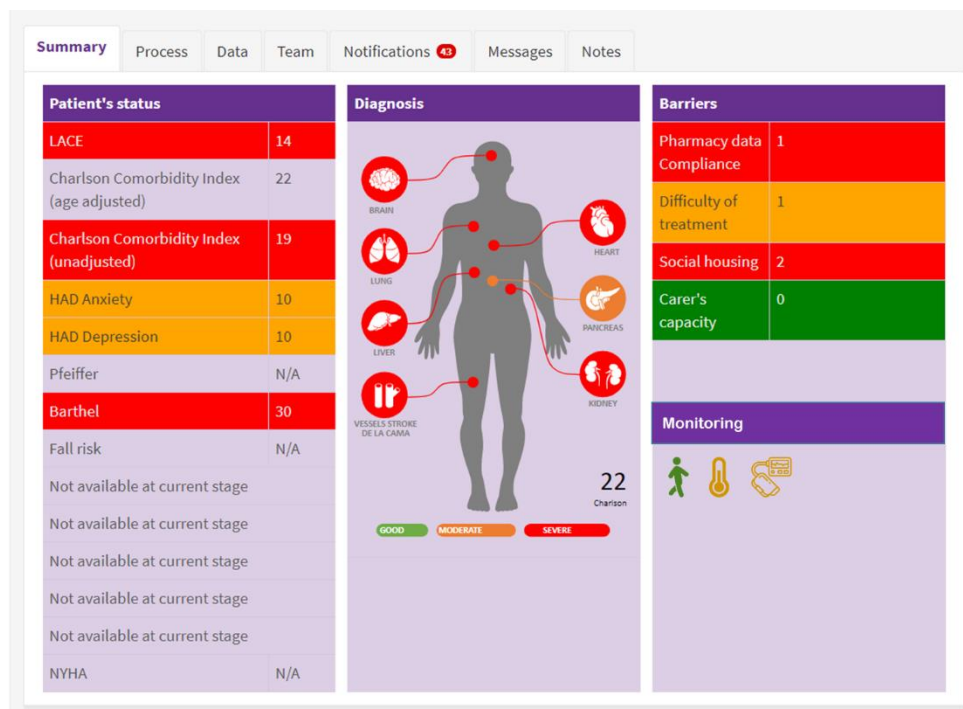


Figure 45 - Example of monitoring tasks displayed in the summary page (physical activity, temperature, and blood pressure).

Clinicians also asked to remove the sentence “Not available at current stage”, putting only the data/information already collected.

### 6.1.4 List of Cases

For the sake of usability and clarity, clinicians of Case Study 2 asked for having an icon for each case in order to visually know the status of the patient. The suggested icon is a traffic light: it would be red when the patient has not been admitted to the hospital, yet; yellow when s/he has been admitted to the hospital; and green, when the patient has been discharged from the hospital.

Clinicians also asked to add an icon “i” for informing regarding the meaning of each part of the page and the corresponding functionality.



### 6.1.5 Change of a Prescription

One of the requirements that have been asked by the clinicians and that was mandatory to start the studies was the possibility to edit tasks and questionnaires of a case. This functionality is currently working and clinicians may have the possibility to change/correct any form/questionnaire.

Even if it applies also in the case of prescriptions, due to a technical issue related to the integration of the SACM and the SMS, when a prescription is changed in the SACM, this change is not transmitted to the SMS. Thus, we asked clinicians to do not change a prescription and to cancel the current and create a new one, instead.

### 6.1.6 Visualization of the Results of the VAS Questionnaire

The day-to-day use of SACM has revealed that the review of the daily Visual Analog Scale (VAS) for pain monitoring is not practical as the answers to each day appear in a different SACM page. This implies the need to change the page for every day to be reviewed (which is very annoying and difficult for daily comparisons). Figure 46 shows how the results of the VAS are depicted in the SACM.

Questionnaire Frequency \*  
1

Questionnaire Frequency Unit \*  
Days

Max delay in minutes \* ⓘ  
120

Slots to take the measurements \* ⓘ  
Lunch

Max. Repetitions per Day \* ⓘ  
1

**Patient Questionnaires \***

State: ACTIVE

Last Modification: May 27, 2019 01:45

How would you score your pain today? Range 0-10, with 0 = no pain and 10 = the most pain you have experienced. \*  
2

CORRECT TERMINATE

Figure 46 - Example of questionnaire with unique answer (VAS). To see the answer of each day, the professional has to use the arrows on the right.

Therefore, as a new requirement, professionals asked for a table with the answer given each day. In other words, each line of the table would correspond to a given day and the corresponding answer.

### 6.1.7 Visualization of the Results of the Simple Tasks

The so-called simple tasks are rehabilitation tasks that were required by ASSUTA to monitor activities such as moving a leg or an arm (the full list of available simple tasks is reported in D4.3 "Advanced



monitoring tools”). Through the SMS, the patient may check if s/he did or did not a prescribed simple task. Accordingly, this information is transmitted to the SACM and visualized. Currently, this visualization is given in form of a continuous line that connect together the corresponding points (1 in case the task has been done, 0 otherwise). Clinicians asked to change the graph, because it should specify for each date if it has been executed or not. The continuous graph is meaningfulness in this case.

### 6.1.8 Team Page and Team Members

The functionality of displaying the list of team members in the SACM was added during the last part of the project. Thus, some integration with the SMS are still missing. In particular, in Lleida it happened that a patient changed her address and, thus, the CAP (Primary Attention Center). For this reason, the primary team (primary clinician, primary nurse) has been changed in the case study, updating the team (team page). Nevertheless, the SACM does not report this change to SMS. Thus, the previous team members still receive the chat messages. Seemly, all the notifications are still received by the ex-team members.

## 6.2 The Integration of the Decision Support Systems

All the three systems developed by UNIMORE offer great opportunities for future improvement, integration, and exploitation.

The Risk DSS is ready for integration, meaning that whenever either enough data will populate the SACM or a suitable dataset becomes available, it can be integrated with the SACM. At the backend level, the Risk DSS will apply a (set of) prediction model(s) chosen by each clinical site (e.g., readmission 30 days, number of exacerbations in next year, etc.) to each new data sample (patient) registered into the SACM, as soon as the evaluation stage has been completed (as depicted in Figure 47). The SACM, in fact, already offers a “data export” functionality enabling to access the whole dataset of each case, which can conveniently be exploited by the Risk DSS to feed its prediction models. The Risk DSS prediction could then be written to a dedicated data field in the SACM, and displayed to the professionals.

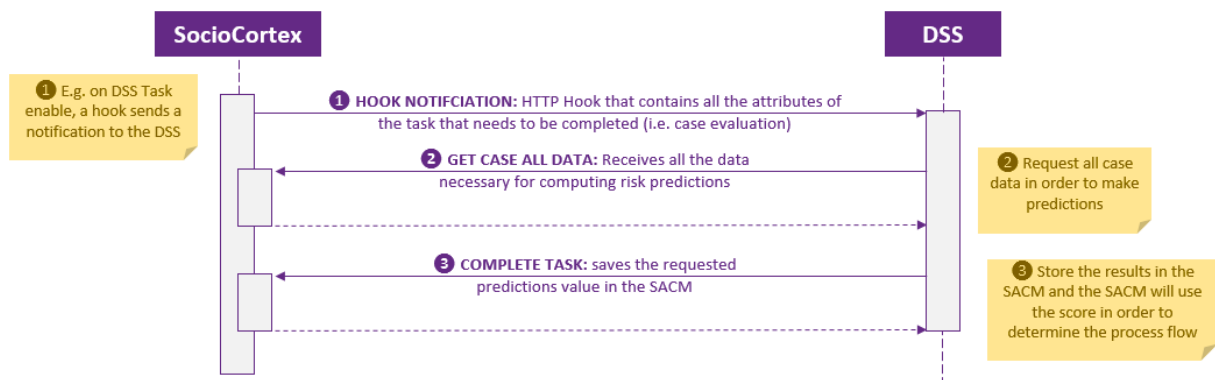


Figure 47 Envisioned integration of the Risk DSS with the SACM backend.



Accordingly, at the frontend level, integration can be as simple as adding a (set of) text field(s) to the SACM summary screen of each case automatically filled by the Risk DSS backend with the prediction (an example of how it could look is depicted in Figure 48). A more complex integration would let users exploit a dedicated screen (such as the testing frontend described in D3.2) to inspect, select, fine-tune, namely manage the prediction models available in the Risk DSS backend, either in plugin or learning mode. Yet another level of integration could be to offer clinicians a way to also configure the learning process. These integrations are much more difficult technically and are also subject to active research in the academic community.

The screenshot shows a patient case summary for 'Groningen CS2 - Elo Test UMCG' (Age: 20, Current Stage: Case Evaluation, Case ID: ymjfocu5vyxc). The interface includes tabs for Summary, Process, Data, Team, Notifications (8), Messages (1), and Notes. The Summary tab is active and displays three main sections: Nutritional, Site of Surgery, and Functional. The Nutritional section shows 'Not available at current stage'. The Site of Surgery section features a human silhouette with labels for anatomical regions: HEAD NECK, THORACIC, ABDOMINAL (highlighted in red), PELVIC, SKIN, UPPER EXTREMITY, and LOWER EXTREMITY. Below the silhouette are 'UNHARMED' and 'SURGICAL SITE' buttons. The Functional section shows 'Not available at current stage' and a 'Risk DSS predictions' table:

Risk DSS predictions	
Readmission 30 days	87%
Exacerbations 1 year	2

Below the Functional section, there is a 'Frailty' section showing 'Not available at current stage' and 'ASA 3'.

Figure 48 Envisioned integration of the Risk DSS with the SACM frontend.

As far as the Mapping DSS is concerned, although integration has already been achieved, it could be even tightened. For instance, it could be possible to link directly to the questionnaire in the SACM behind a risk score by clicking on the correspondent cell in the table view in the Mapping DSS.



The Clinical Pathways DSS is undoubtedly the most critical to integrate. First of all, the same issues about data availability discussed for the Risk DSS hold here, too. Secondly, although backend integration may resemble the one envisioned for the Risk DSS, the frontend is a different story: as the Clinical Pathways DSS has to suggest viable treatments, essentially, it has to build a work-plan, hence a suitable graphical depiction is to be designed. Thirdly, due its nature of a decision support system, the clinician has to be able to (a) inspect the motivations that guided the DSS suggestions and (b) accept, reject, or modify the individual suggested pathway(s).

### 6.3 A Graphical Support for Case Modelling

Currently, to model a case and, thus, the overall process with all the forms, questionnaires, prescription, etc., the SACM relies to an ad-hoc XML file. Figure 49, Figure 50, Figure 51, Figure 52, Figure 53, and Figure 54 show three example of the code and the corresponding generated interface.

```

<EntityDefinition id="GCS2_GFI" description="Groningen Frailty Indicator (GFI)">
  <AttributeDefinition id="gfi1" type="enumeration" multiplicity="exactlyOne" description="Kan patiënt zonder enige hulp van iemand anders zelfstandig deze taak uitvoeren? - Boodschappen doen?">
    <EnumerationOption value="1" description="No"/>
    <EnumerationOption value="0" description="Yes"/>
  </AttributeDefinition>
  <AttributeDefinition id="gfi2" type="enumeration" multiplicity="exactlyOne" description="Kan patiënt zonder enige hulp van iemand anders zelfstandig deze taak uitvoeren? Buitenshuis rondlopen?">
    <EnumerationOption value="1" description="No"/>
    <EnumerationOption value="0" description="Yes"/>
  </AttributeDefinition>
  <AttributeDefinition id="gfi3" type="enumeration" multiplicity="exactlyOne" description="Kan patiënt zonder enige hulp van iemand anders zelfstandig deze taak uitvoeren? - Aan - en uitkleden?">
    <EnumerationOption value="1" description="No"/>
    <EnumerationOption value="0" description="Yes"/>
  </AttributeDefinition>
  <AttributeDefinition id="gfi4" type="enumeration" multiplicity="exactlyOne" description="Kan patiënt zonder enige hulp van iemand anders zelfstandig deze taak uitvoeren? Toiletbezoek?">
    <EnumerationOption value="1" description="No"/>
    <EnumerationOption value="0" description="Yes"/>
  </AttributeDefinition>
  <AttributeDefinition id="gfi5" type="enumeration" multiplicity="exactlyOne" description="Ondervindt patiënt problemen in het dagelijks leven door slecht zien?">
    <EnumerationOption value="0" description="No"/>
    <EnumerationOption value="1" description="Yes"/>
  </AttributeDefinition>
  <AttributeDefinition id="gfi6" type="enumeration" multiplicity="exactlyOne" description="Ondervindt patiënt problemen in het dagelijks leven door slecht horen?">
    <EnumerationOption value="0" description="No"/>
    <EnumerationOption value="1" description="Yes"/>
  </AttributeDefinition>
  <AttributeDefinition id="gfi7" type="enumeration" multiplicity="exactlyOne" description="Is patiënt afgelopen 6 maanden veel (6kg) afgevallen zonder dit zelf te willen? (of 3 kg in een maand)">
    <EnumerationOption value="0" description="No"/>
    <EnumerationOption value="1" description="Yes"/>
  </AttributeDefinition>
  <AttributeDefinition id="gfi8" type="enumeration" multiplicity="exactlyOne" description="Gebruikt patiënt momenteel 4 of meer verschillende soorten medicijnen?">
    <EnumerationOption value="0" description="No"/>
    <EnumerationOption value="1" description="Yes"/>
  </AttributeDefinition>
  <AttributeDefinition id="gfi9" type="enumeration" multiplicity="exactlyOne" description="Heeft patiënt momenteel klachten over zijn geheugen (of bekend met dementie)?">
    <EnumerationOption value="0" description="No"/>
    <EnumerationOption value="1" description="Yes"/>
    <EnumerationOption value="2" description="Sometimes"/>
  </AttributeDefinition>

```

Figure 49 – Definition of a questionnaire to answered by professionals through the SACM (example from CS2 in UMCG), extract of the XML file.



**Groningen Frailty Indicator (GFI)**

Clinician: <b>Felix Michel</b>	Professional
Role: <b>Professional</b>	
Due Date: <b>25-Jan-2019</b>	
State: <b>Active</b>	

Kan patiënt zonder enige hulp van iemand anders zelfstandig deze taak uitvoeren? - Boodschappen doen? \*

No  Yes

Kan patiënt zonder enige hulp van iemand anders zelfstandig deze taak uitvoeren? Buitenshuis rondlopen? \*

No  Yes

Kan patiënt zonder enige hulp van iemand anders zelfstandig deze taak uitvoeren? - Aan - en uitkleden? \*

No  Yes

Kan patiënt zonder enige hulp van iemand anders zelfstandig deze taak uitvoeren? Toiletbezoek? \*

No  Yes

Ondervindt patiënt problemen in het dagelijks leven door slecht zien? \*

No  Yes

Figure 50 - Definition of a questionnaire to answered by professionals through the SACM (example from CS2 in UMCG), the corresponding interface.

```

<DualTaskDefinition id="LCS2_PhysicalActivityABMP" externalId="PhysicalActivity"
description="Activitat física. Després d'hospitalització"
ownerPath="LCS2_Settings.PhysiotherapistL" dueDatePath="LCS2_Settings.WorkplanDueDate" isMandatory="false" repeatable="PARALLEL" activation="MANUAL" entityDefinitionId="LCS2_PhysicalActivityAH" >
  <HttpHookDefinition on="ACTIVATEAUTOMATEDPART" url="http://integration-producer:8081/v1/producer/point-to-point/sacm/prescription" method="POST" failureMessage="Could not create prescription" >
  <HttpHookDefinition on="TERMINATE" url="http://integration-producer:8081/v1/producer/point-to-point/sacm/prescription/terminate" method="POST" failureMessage="Could not terminate prescription" >
  <TaskParamDefinition part="HUMAN" path="LCS2_WorkplanAfterHospitalization.LCS2_PhysicalActivityAH.startDate" isReadOnly="false" isMandatory="true"/>
  <TaskParamDefinition part="HUMAN" path="LCS2_WorkplanAfterHospitalization.LCS2_PhysicalActivityAH.endDate" isReadOnly="false" isMandatory="true"/>
  <TaskParamDefinition part="HUMAN" path="LCS2_WorkplanAfterHospitalization.LCS2_PhysicalActivityAH.dailysteps" isReadOnly="false" isMandatory="true"/>
  <TaskParamDefinition part="HUMAN" path="LCS2_WorkplanAfterHospitalization.LCS2_PhysicalActivityAH.dailylowlevel" isReadOnly="false" isMandatory="true"/>
  <TaskParamDefinition part="HUMAN" path="LCS2_WorkplanAfterHospitalization.LCS2_PhysicalActivityAH.dailymediumlevel" isReadOnly="false" isMandatory="true"/>
  <TaskParamDefinition part="AUTOMATED" path="LCS2_WorkplanAfterHospitalization.LCS2_PhysicalActivityAH.measurement" isReadOnly="false" isMandatory="true"/>
</DualTaskDefinition>

```

Figure 51 - Definition of a prescription of physical activity (example from CS2 in Lleida), extract of the XML file.



**Activitat física - Després d'hospitalització**

Clinician:	Albert Bigorda -
Role:	Physiotherapist
Due Date:	Set Date-
State:	▶ Waiting for clinician input ■ Available

**Data d'inici \***

**Data de fi \***

**Número de passos a fer durant el dia \***

**Mínim de minuts d'intensitat baixa a fer durant el dia (caminar, tasques domèstiques lleugeres, jugar amb nens, passejar mascotes...) \***

**Mínim de minuts d'intensitat intermitja a fer durant el dia (caminar pas ràpid, bicicleta, nadar...) \***

**Mesures \***

Pending...

CLEAR
COMPLETE
TERMINATE

Figure 52 - Definition of a prescription of physical activity (example from CS2 in Lleida), interface.

```

<EntityDefinition id="I101_PatientQuestionnaire" description="השאלון למילוי מטופלים"/>
<AttributeDefinition id="type" type="enumeration" multiplicity="exactlyOne" description="סוג השאלון" additionalDescription="סוג השאלון למלא" />
<EnumerationOption value="SF12" description="SF12"/>
<EnumerationOption value="EQ5D" description="EQ5D"/>
<EnumerationOption value="LEAVE" description="ישנתי חזרה הביתה"/>
<EnumerationOption value="BAT" description="למשל אכלתי חייט"/>
<EnumerationOption value="FBI" description="פגשתי חולה חולה/ה חולה חולה"/>
<EnumerationOption value="DRINK" description="השתכרתי חולה חולה"/>
</AttributeDefinition>
<AttributeDefinition id="startdate" type="date.after(TODAY)" multiplicity="exactlyOne" description="תאריך התחלה"/>
<AttributeDefinition id="enddate" type="date.after(startdate)" multiplicity="exactlyOne" description="תאריך סיום"/>
<AttributeDefinition id="freq" type="number.min(0)" defaultValues="[1]" multiplicity="exactlyOne" description="תדירות מילוי השאלון"/>
<AttributeDefinition id="frequency" type="enumeration" defaultValues="[DAYS]" multiplicity="exactlyOne" description="תדירות מילוי השאלון"/>
<EnumerationOption value="DAYS" description="ימים"/>
<EnumerationOption value="WEEKS" description="שבועות"/>
<EnumerationOption value="MONTHS" description="חודשים"/>
</AttributeDefinition>
<AttributeDefinition id="maxdelay" type="number.min(0).max(1440)" defaultValues="[120]" multiplicity="exactlyOne" description="אורך קטעי מילוי השאלון על ידי המטופל" additionalDescription="אורך קטעי מילוי השאלון על ידי המטופל" />
<AttributeDefinition id="timeofday" type="enumeration" multiplicity="atLeastOne" description="זמן מילוי השאלון" additionalDescription="זמן מילוי השאלון" />
<EnumerationOption value="BREAKFAST" description="7:30 בוקר"/>
<EnumerationOption value="LUNCH" description="12:30 ארוחת צהריים"/>
<EnumerationOption value="AFTERNOONSNAKE" description="16:00 ארוחת אחר הצהריים"/>
<EnumerationOption value="DINNER" description="19:00 ערב"/>
<EnumerationOption value="BPFORSLEEP" description="21:00 לפני השינה"/>
<EnumerationOption value="AFTERMIDNIGHT" description="לפני שמינה לילית" additionalDescription="לפני שמינה לילית" />
</AttributeDefinition>
<AttributeDefinition id="repetitionsperday" type="number.min(0)" multiplicity="exactlyOne" description="כמות שאלונים למילוי השאלון ביום" additionalDescription="Maximum repetitions of the questionnaire per day."/>
<AttributeDefinition id="questionnaires" type="json" multiplicity="any" uriReference="patientquestionnaires" description="השאלון למילוי על ידי המטופל" />
</EntityDefinition>
<EntityDefinition id="I001_Advice" description="המלצה"/>
<AttributeDefinition id="title" type="string" multiplicity="exactlyOne" description="כותרת ההמלצה"/>
<AttributeDefinition id="expiredate" type="date.after(TODAY)" multiplicity="exactlyOne" description="תאריך תפוגה"/>
<AttributeDefinition id="explanation" type="longtext" multiplicity="exactlyOne" description="תיאור הסיבה"/>
<AttributeDefinition id="visualizationdate" type="date" multiplicity="exactlyOne" description="תאריך שיוצג המלצה למטופל"/>
</EntityDefinition>

```

Figure 53 - Definition of a prescription of self-questionnaires, to be answered by the patients in the SMS (example from CS1 in ASSUTA), extract of the XML file.



שאלון למילוי על ידי המטופל

Clinician:	Charles Miller -
Role:	Professional
Due Date:	10-Dec-2018 -
State:	▶ Waiting for clinician input ■ Available

▲ Professional    ▲ Patient

סוג השאלון \*

SF12     EQ5D     האם יצאת מהבית היום?     האם אכלת היום?     איך אתה מרגיש/ה היום?     האם שתיית היום?

תאריך התחלה \*

mm/dd/yyyy

תאריך סיום \*

mm/dd/yyyy

תדירות מילוי השאלון \*

1

יחידות תדירות מילוי השאלון \*

ימים     שבועות     חודשים

איחור מקסימלי בדקות \*

120

זמן מילוי השאלון \*

7:30 בוקר

Figure 54 - Definition of a prescription of self-questionnaires, to be answered by the patients in the SMS (example from CS1 in ASSUTA), the corresponding interface.

What we learned from CONNECARE is that processes are very hard to model. On the one hand, professionals have the domain knowledge but not the technical capability. On the other hand, the technicians have the required capability but not the domain knowledge. Thus, what should be done in the future to scale-up the SACM could be a graphical tool that can be used by a clinician/technician expert in processes with a catalogue of items, questionnaires, scales to be selected to model the process. The idea is based on CAD (Computer-Aided-Design) software. The development of the graphical Web tool will allow to the health and social care professionals to adapt the design of the process to:

- Any clinical aim: any clinical process can be adapted to the interface regardless being surgical or medical, situated in hospital or community, or combination of those;
- Any clinical environment: (i) health care environments, such as ambulatory (community), general primary care; (ii) specialized primary care, by diseases or clinical requirements or by medical specialty; (iii) hospital setting, such as specialized hospital offices; (iv) specialized units: usually multidisciplinary; (v) emergency rooms aimed at improving communication with primary care and transitional care units per personnel before discharge from the department; (vi) transitional care, such as oncology-care, palliative-care, home hospitalization; and (vii) shared care in complex medical and surgical patients with specific risk profiles
- Any key health care situation or phase: to support patients and carers before a scheduled hospitalization, during hospitalization for any cause, and/or during the hospital discharge process and beyond.



- Ambulatory patient: to support to a patient with one or more chronic conditions and to enable surveillance of specific profiles of patients.
- Carry out clinical research: The systematic work based on validated tools for clinical healthcare enable linking the collected information to a standard data-base record. Therefore, any health care action with its standard metrics is linked to an input of information and can be used for research in accordance with security procedure security procedures and necessary permissions.



## References

- [1] Hernandez-Mendez, A., Michel, F., Matthes, F. A Practice-Proven Reference Architecture for Model-Based Collaborative Information Systems. Enterprise Modelling and Information Systems Architectures – International Journal of Conceptual Modeling. Vol 13. 2018.
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- [3] Michel, F., Hernandez-Mendez, A., Matthes, F. An-Overview-of-Tools-for-an-Integrated-and-Adaptive-Healthcare-Approach. AdaptiveCM 2018 – 6th International Workshop on Adaptive Case Management and other non-workflow approaches to BPM. Stockholm. 2018