



C3-Cloud

“A Federated Collaborative Care Cure Cloud Architecture for Addressing the Needs of Multi-morbidity and Managing Poly-pharmacy”

PRIORITY Objective H2020-PHC-25-2015 - Advanced ICT systems and services for integrated care

D7.3 Personalised Care Plan Development Platform

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EXECUTIVE SUMMARY

WP7 is responsible for developing ICT platforms (Personalised Care Plan Development Platform & Coordinated Care and Cure Delivery Platform) and supporting Clinical Decision Support Modules to enable multidisciplinary teams of health and social care givers to collaboratively create, execute and monitor personalised care plans through the reconciliation of clinical guidelines for individual chronic diseases.

Task 7.3 concerns the implementation of the Personalised Care Plan Development Platform (PCPDP), based on deliverables D8.1 Requirements and Use Cases of C3-Cloud Pilot Application, D3.2 Requirements Specification of the C3-Cloud Architecture, the Document of Action, and finally the user-centred design activities that have been carried out along the project timeline. Task 7.3 started in month 9 (1 January 2017) and has ended in month 22 (28 February 2018).

The deliverable D7.3 describes the demonstrator of the C3-Cloud Personalised Care Plan Development Platform (PCPDP). This document defines functionalities that are provided by the PCPDP and also refers to the use cases identified in the requirements analysis phase. It presents the HL7 FHIR STU3 compliant C3-Cloud care plan model in full detail, as well as the user-centred design process followed. Furthermore, it provides details about the software implementation by mentioning the preferred technologies, frameworks and libraries. It presents a brief overview of the performed integration activities with the other C3-Cloud software components. Finally, this document also includes a complete step-by-step manual for the PCPDP Web application. The main purpose of the demonstrator is to show the progress of the implementation of the C3-Cloud collaborative care plan management tool to implement the use cases in a concrete way.

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1. DOCUMENT OVERVIEW

1.1. Purpose

This deliverable, D7.3, is a description of the demonstrator of the C3-Cloud Personalised Care Plan Development Platform (PCPDP). The main objective of PCPDP is to enable the creation of personalised integrated care plans for patients with multi-morbid chronic conditions by utilising clinical guideline driven Clinical Decision Support (CDS) services. Care plan management has to take place collaboratively with involvement of a multi-disciplinary care team composed of health professionals (GP, nurse, specialist, dietitian, physiotherapist, etc.) and social care workers. Patients and their informal care givers are also participants of the integrated care planning process; however, they participate via the Patient Empowerment Platform (PEP) by WP5.

1.2. Outline of the deliverable

The document is organized as follows:

- Section 2 summarizes the functionalities that are provided by the PCPDP, by also referring to the use cases identified in the requirements analysis phase [D3.2].
- Section 3 presents the care plan model used in C3-Cloud in detail.
- Section 4 provides details about the software implementation of PCPDP and the user-centred design process followed.
- Section 5 provides a brief overview of activities that have been performed for integration of PCPDP with other C3-Cloud software components (integration will be presented in detail in D7.4).
- Section 6 presents a complete step-by-step demonstration, i.e. a manual, of the PCPDP Web application for management of a personalised care plan.
- Section 7 concludes the document by referring to the future plans for integration and deployment.

1.3. Context

The Personalised Care Plan Development Platform (PCPDP) is the digital multi-actor knowledge exchange environment for shared and informed decision making during the development of the personalised care plans of the elderly with chronic diseases. In order to achieve the functionality of this platform, existing patient electronic health records received from the local EHR systems via C3-Cloud Technical Interoperability Suite (TIS) and patient reported observations and feedback from the C3-Cloud Patient Empowerment Platform (PEP) are taken into account in care planning. Furthermore, C3-Cloud Clinical Decision Support (CDS) services are utilised for enabling personalised goal recommendations (e.g., blood pressure targets, dietary targets) and intervention recommendations (medication therapies, guidance on contradicting medications, laboratory test requests, referrals to specialists, scheduling follow-up timings) to the care team members based on clinical guidelines for individual chronic diseases and reconciliation rules for disease combinations defined by the C3-Cloud clinical experts.

In the Description of Action (DoA), there are two related tasks and corresponding deliverables that are involved in personalised care plan management: Task 7.3 - Personalised Care Plan Development Platform (PCPDP) and Task 7.4 - Development of Coordinated Care and Cure Delivery Platform (C3DP) through Integration of C3-Cloud Components. PCPDP handles the creation and editing of a personalised care plan by care team members, while C3DP provides the holistic platform that acts as a workflow engine to facilitate organisation, planning, and monitoring of integrated care activities and flagging of unperformed activities and unmet goals for future follow-up within the scope of a personalised care plan. Although PCPDP and C3DP are located in separate tasks, this does not mean that there are separate (Web) applications for editing and follow-up of a care plan. In order to prevent confusion among the C3-Cloud partners, it has been agreed to position PCPDP as a sub-component of

the C3DP during the architectural design phase. Hence, it should be noted that PCPDP and C3DP can be used interchangeably in the remaining of this document. The name of the Web application, which is the single-page entry point for the care team members for care plan management, is C3DP.

Besides, Task 7.4 is also responsible for integration of all the software components that are being developed in work packages 5, 6 and 7, which will be explained in detail in the upcoming deliverable D7.4, due Month 24 of the project.

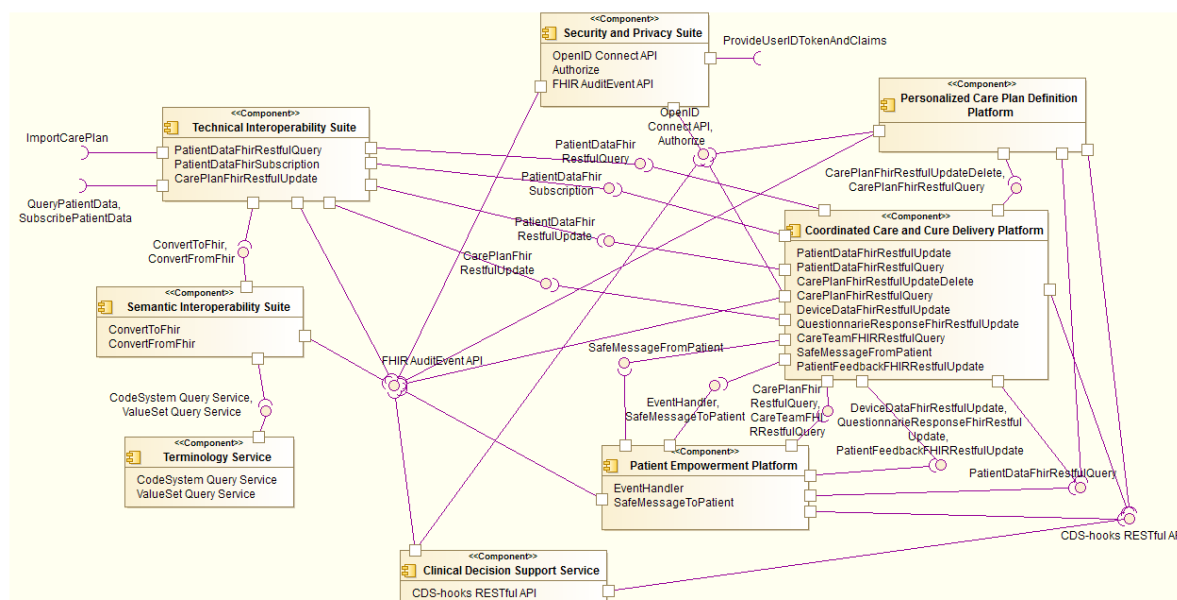


Figure 1 C3-Cloud Component Diagram from D3.3 – Conceptual Design

1.4. Abbreviations and Acronyms

Abbreviation	Definition
BC	Basque Country
C3DP	Coordinated Care and Cure Delivery Platform
CRUD	Create, Read, Update, Delete
DoA	Description of Action
DSTU	Draft Standard for Trial Use
EHR	Electronic Healthcare Record
EMR	Electronic Medical Record
GP	General Practitioner
FHIR	Fast Healthcare Interoperability Resources
HL7	Health Level Seven
HTTP	Hypertext Transfer Protocol
IdP	Identity Provider
PCPDP	Personalised Care Plan Development Platform
PEP	Patient Empowerment Platform
RJH	Region Jämtland Härjedalen

Abbreviation	Definition
SIS	Semantic Interoperability Suite
SPS	Security and Privacy Suite
STU	Standard for Trial Use
SWFT	South Warwickshire NHS Foundation Trust
TIS	Technical Interoperability Suite
UI	User Interface
UX	User Experience

2. PCPDP SCOPE

2.1. Use Cases for the PCPDP

Ten use cases have been identified for the Personalised Care Plan Development Platform (PCPDP) of C3-Cloud in D3.2 - Requirements Specification of the C3-Cloud Architecture [D3.2]:

- PCPDP-1: Create Care Plan
- PCPDP-2: Add new Care Plan from a Core Care Plan
- PCPDP-3: Define new Care Plan
- PCPDP-4: Update Existing Care Plan
- PCPDP-5: Review Care Plan for Reconciliation
- PCPDP-6: Reconcile Care Plans for Multiple Conditions
- PCPDP-7: Find Care Plan
- PCPDP-8: Tag Care Plan Items
- PCPDP-9: Export Care Plan
- PCPDP-10: Import Care Plan

As explained in the previous section, starting from the architectural design phase of C3-Cloud, PCPDP and Coordinated Care and Cure Delivery Platform (C3DP) have been merged and PCPDP has been positioned as a sub-component of C3DP. Fifteen use cases, which were identified for C3DP in D3.2 are also listed here, as these use cases have also been implemented and explained in this document for preserving the integrity of all care plan management functionalities:

- C3DP-1: Close Care Plan
- C3DP-2: Invite a Care Team Member
- C3DP-3: Add Care Team Member
- C3DP-4: Remove Care Team Member
- C3DP-5: Discover Care Team
- C3DP-6: Send Message to Care Team Member(s)
- C3DP-7: Manage Messages
- C3DP-8: Invite Care Team Members to a Virtual Care Review Meeting
- C3DP-9: Organize Virtual Care Review Meeting
- C3DP-10: Share Care Plan with Care Team Members
- C3DP-11: Record Patient Observations
- C3DP-12: Associate Supportive Content
- C3DP-13: Monitor Change
- C3DP-14: Care Plan Dashboard
- C3DP-15: Access Educational Material

The details of these use cases and all associated system requirements (functional, information, usability, security, etc.) are all described in D3.2.

2.2. Revised Functionalities of the PCPDP

As it is the case in most software development projects, the starting point for implementation of PCPDP / C3DP was the requirements listed in the previous section, which have been revised with minor modifications based on feedback from the clinical experts, i.e. the actual users of the final system to be piloted. This was achieved by several user-centred design iterations that have been carried out (see Section 4.3) between SRDC and pilot site representatives. The final revised list of major functionalities provided by the C3DP for personalised and coordinated care planning are explained below. All these functionalities are presented step by step on the C3DP user interfaces in Section 6.

- **Review of medical summary:** All the patient data that is provided by the local EHR/EMR systems, and also by the patient via Patient Empowerment Platform (PEP), -including

conditions, medications, allergies, lab results, vital signs, procedures and social history- are presented to the care team members in a single location. It is not possible to provide any new data via the medical summary view.

- **Cross-check of all patient data that are needed as input by the CDS services:** This is a good example of a requirement that was not discovered during the requirements analysis or conceptual design phase, but only after having a working prototype and performing an early usability analysis with the actual clinical experts, who will use and evaluate the system during pilot studies. C3-Cloud clinical experts indicated that they would like to see and validate all patient data to be sent to CDS services for getting personalised goal and treatment suggestions. Although the C3DP will retrieve all patient data provided by the local EHR/EMR systems and integrated via the Interoperability Layer (WP6), clinical experts indicated that there can be missing or incomplete data even in these sources, and they can complete them via C3DP user interfaces before calling the CDS services. In order to address this emerging requirement, all clinical concepts that are checked by the CDS services relevant to the health concerns of the patient, for providing personalised goal and activity recommendations, are now presented to the care team members, either in a single holistic list in the “Chronic Disease Profile” view, or in a more context aware manner associated with each high-level goal (e.g., glucose management, blood pressure management). For example, the lipid management CDS service checks the existence of three diseases (and some other parameters like lab results and specific medications) in its decision tree: type 2 diabetes, chronic kidney disease and cardiovascular disease. The patient records retrieved from the local EHR system show that the patient has type 2 diabetes, but there is no information about the existence of chronic kidney disease and cardiovascular disease. The GP of the patient can declare that this patient has also a cardiovascular disease, which was somehow missing in the patient’s EHR system records. Such newly provided patient data via the C3DP interface can be provided back to the original EHR/EMR systems.
- **Management of the care plan building blocks: goals, activities and education materials:** In addition to the addressed health concerns and risk factors, an integrated care plan is mainly composed of goals to manage the health concerns and activities (i.e. interventions) to achieve these goals and improve the associated health concerns. In C3-Cloud, education materials for the empowerment of the patients are also part of the care plans, while they are treated separately from the rest of the activities. There are three ways of adding a goal / activity / education material to a care plan, as follows:

 - **Manual entry from scratch:** Care team members can, at any time, create a goal / activity / education material themselves via the C3DP user interface.
 - **Recommendations from the CDS services:** Personalised goal, activity and education material suggestions, provided by the CDS services according to patient data can be directly added to the care plan of a patient by the care team members, or after some modifications.
 - **Transfer from the older care plan:** When provided by the local systems of the pilot sites, it is possible to transfer existing goals and activities from a treatment plan of a patient into an integrated care plan during its initialization.
- **“Execution” of a care plan:** Integrated care planning is a continuous process. Ideally, an integrated care plan lives with the patient and is adjusted to the most recent patient context. It is updated during planned and unplanned encounters of the patient with health professionals and social care workers, and also with patient provided feedback via the Patient Empowerment Platform. All updates can be shared with the local EHR/EMR systems bilaterally as well. Hence, “execution” of a care plan refers to the continuous follow-up and update of an integrated care plan. This can happen in a number of ways in C3-Cloud:

- **Updating the progress of goals and activities:** The status of any goal or activity can be updated (e.g., a goal can be set as “achieved” or “on-target”) by a care team member. The patient can also provide feedback on their progress.
- **Re-execution of CDS services during planned and unplanned encounters:** This is akin to the CDS service usage for the first time during initialization of a care plan. Relevant progress in the patient status is reflected in the recommendations of the CDS services.
- **Display of patient provided data:** Patient and his informal care giver are active participants of the care planning process. Goals and activities are decided with his active involvement, and for an activity that is assigned to themselves, the patient is able to provide update via the Patient Empowerment Platform (PEP). Patient provided data includes questionnaire responses, medical device measurements (e.g., blood glucose, blood pressure), daily meal photographs and more. All patient provided data are matched with the corresponding care plan items and shown to the care team members.
- **Commenting on the care plan items:** It is also possible to comment on specific goals and activities of a care plan, which are visible to the care team members.
- **Management of the care team:** It is possible to invite new care team members to a care plan, during initialization or at any time. An invitation is subject to the confirmation of the invited care team member, who is informed via a notification in the system and an email depending on the preference of the pilot sites. The Care Team Manager, who is always the GP of the patient in all 3 pilot sites of C3-Cloud, can also remove a professional from a care team, or a member may want to leave a care team. It is also possible for a health professional or social care worker to request joining an existing care team for a specific patient. Different roles can have different rights in the care team; for example, a nurse assistant or a social care worker can see a care plan but not modify it.
- **Communication among care team members and with the patient / informal care giver:**
 - **Asynchronous messaging:** C3DP has its own messaging module that enables safe messaging among all care team members, and also with the patients due to the integration between C3DP and PEP. HL7 FHIR Communication resource is used for messaging.
 - **Organization of tele/video conferences:** It will be possible to organize a tele/video conference session among the care team members (e.g., for a virtual case review meeting) and also bilaterally between a care team member and the patient. Among all the functionalities listed in this section, only this one is still in progress as it has strong dependency on the existing teleconferencing solutions of the pilot sites and integration work is ongoing. The setup in each pilot site is different for this purpose. This activity will continue in Task 7.4.
- **Dashboard view:** Dashboard view enables a signed in care team member to quickly go over the important updates in the care plans of all her patients since the previous login, such as new messages received, awaiting appointments, new system notifications.
- **Activity calendar:** It enables view and update of scheduled activities of a care team member on a calendar.
- **Real-time system notifications:** Real-time system notifications are implemented for several events (e.g., for care plan update, new patient feedback, new message, invitation to a care team, etc.). When the user is already logged in to the system, such notifications are displayed in real time. It is also possible to access care team members via email for offline scenarios. SMS option was dropped by the pilot sites for real-time clinical notifications.

3. CARE PLAN MODEL

The details of the care plan model, used in the C3-Cloud project, are presented in this section. In the first two sub-sections, an overview of the underlying models and specifications that form the basis of the C3-Cloud Care Plan model is presented. Then, Section 3.3 presents how the generic HL7 FHIR STU3 care plan related resources are specialized as the C3-Cloud Care Plan model. C3-Cloud prefers HL7 FHIR [FHIR] resources, as the common data model and syntax for both care plan related artefacts and clinical patient data, and the RESTful FHIR API for data exchange interactions in the overall architecture as a design decision [D3.3].

3.1. HL7 Care Plan Domain Analysis Model

HL7 Patient Care Workgroup (PCW) [HL7-PCW] has balloted the initial Care Plan model in 2007 as DSTU (Draft Standard for Trial Use). However, a number of ballot issues were not resolved satisfactorily and consequently the balloted contents did not reach DSTU status. Later, a new project plan was initiated in 2011 to develop a Domain Analysis Model (DAM) as a common reference to support the development of implementable care plan models. HL7 PCW worked together with various groups including HL7 Workgroups (e.g., EHR, Structured documents), IHE, NEHTA, Canada Health Infoway, and others. The Care Plan DAM project concluded in 2014 after complete resolution of informative ballot 2 comments [CarePlanDAM].

The Care Plan DAM uses the concept care plan in the generic sense. The purpose of the care plan, as defined by HL7 Care Plan DAM, is to:

- define the management action plans for the various conditions (e.g., problems, diagnosis, health concerns) identified for the target of care;
- organize a care plan and check for completion by all individual professions and/or responsible parties (including the patient, caregiver or family) for decision making, communication, and continuity and coordination;
- communicate explicitly by documenting and planning actions and goals;
- permit the monitoring, flagging, evaluating and feedback of the status of goals, actions, and outcomes such as completed, or unperformed activities and unmet goals and/or unmet outcomes for later follow up;
- manage risk related to effectuating the care plan.

Within the scope of Care Plan DAM project, a number of storyboards have been defined as narrative descriptions of clinical scenarios where the care plan is created, accessed, updated or used during the provision of healthcare. The storyboards provide context to the information collected, retrieved, presented and reported in care plans.

Later, by analysing these storyboards, the Care Plan project team has developed a number of care plan model artefacts. A layered modelling approach was used which allows for separation of concerns by business requirements, information requirements and technical interoperability requirements, and to support forward and backward traceability through these layers. The first layer, the conceptual model level, identifies the business domain concepts and concept relationships necessary to define the scope of the domain semantics covered by the subsequent levels. The second layer, the logical information model, elaborates the conceptual model by adding attributes necessary to capture the data elements resulting from dynamic care planning interactions and required for capturing static point in time snapshots of the care plan. At the logical information level, the model retains a one-to-one mapping of all the domain concepts. The logical information model contributes intrinsic data properties necessary to specify a class model with sufficient detail to support interoperability information requirements. Care Plan DAM defines these two levels of abstractions. Realization of the third layer, the platform implementation model is handled by separate efforts as independent technical specifications. These include elements such as CCDA (Consolidated Clinical Document Architecture) specification of the care plan and its exchange and SOA (Service-Oriented Architecture) specifications for coordination of care.

A very brief overview of Care Plan DAM conceptual model is presented in the following sub-section.

3.1.1. Care Plan DAM Conceptual Model

The model consists of an abstract Plan which captures the shared components of collaborative, patient centred and holistic care. The Plan has associations to concepts for Health Concern, Health Goal, Health Risk, Care Barrier, Care Preference, Conversation, Plan Activity (including interventions), Acceptance Review, Plan Review and key care team participations through time and space between the Patient, Provider(s), Care Giver(s) and other Supporting Member(s). Each is listed equally, but it is the Health Concern and the Plan Activity that are directly driving the anticipated Health Goal. The Health Outcome(s) are tied to the health concern, goal and activity allowing evaluation of the progress of care towards the health goals. High level relationships between Care Plan components are depicted in Figure 2.

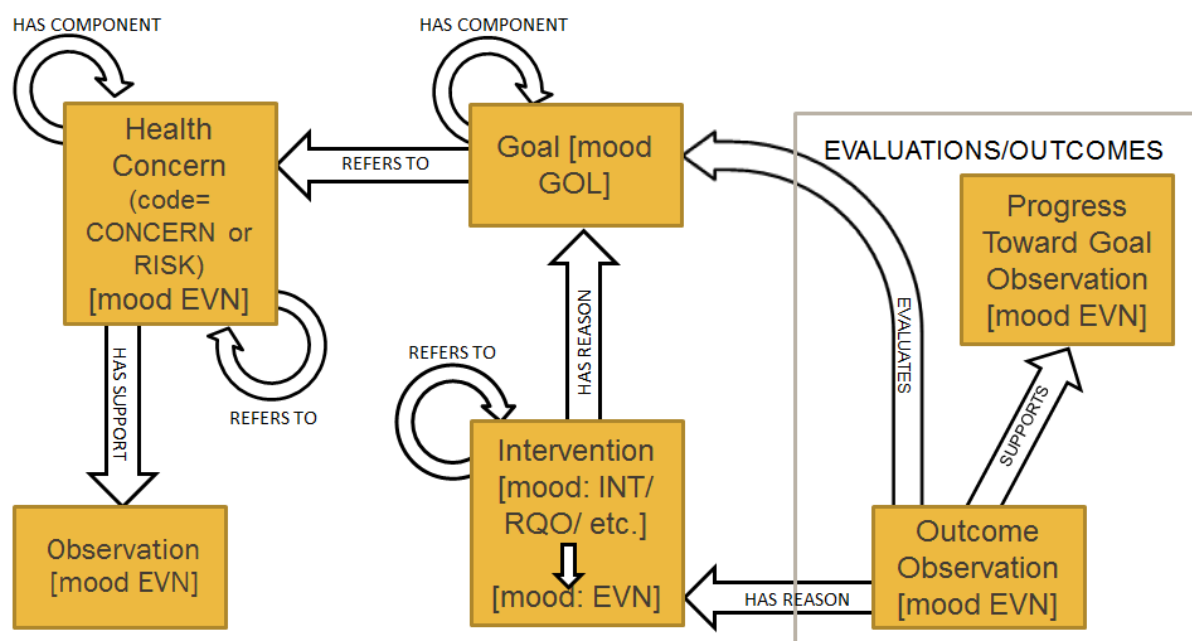


Figure 2 Care Plan Relationship Diagram [C-CDAR2]

The Plan and many of its associated classes support dynamic care team involvement. The Care Plan DAM has the capability to capture information about these participations. The details of the Plan result from the interactions of the Care Team consisting of the Patient and at least optional Providers, Care Givers or Supporting Members. A Plan is not intended to be static but continuously changing based on continual chatter, negotiation and interactions between the various care team members. The Care Plan by design is a collaborative, shared and dynamic structure with controlled Care Team involvement or participation.

A Plan may come into being as a result of one or more patient Health Concerns or, simply, as a result of a patient Health Goal. For patients with some health conditions whether simple, chronic or complex, the Plan will reference one or more Health Concerns. The Health Concern specifies the reason for creating the Plan. In this case, the Health Concern reason eventually leads to the definition of Health Goals as a result of conversations between the patient and his or her providers, care givers and supporting care team.

Certain individuals may have a predisposition to a certain Health Risk, which may or may not become health concern(s) over time. The model supports representation of these Health Risks to enable the care team to monitor them and have the awareness to implement mitigating actions if the need arises. An intervention in turn may present certain Health Risks to the patient which must be closely monitored to

prevent the manifestation of additional health concerns (e.g., the risk of administration of an immunosuppressant, surgery, etc.).

The HL7 Patient Care workgroup has been coordinating the harmonization of this Care Plan model with both HL7 FHIR care plan model, which is presented in the next section, and C-CDA R2 care plan templates.

3.2. HL7 FHIR Care Plan Model

HL7 Fast Healthcare Interoperability Resources [FHIR] is an emerging standards framework created by HL7, which combines the features of HL7 v2, HL7 v3 and CDA product lines while leveraging the latest web standards (such as XML, JSON, HTTP, OAuth) and applying a tight focus on implementation. FHIR solutions are built from a set of modular components called "Resources". These resources can easily be assembled into working systems that solve real world clinical and administrative problems very quickly. FHIR is especially suitable for use in developing mobile phone apps, cloud communications, EHR-based data sharing, and server communication in large institutional healthcare providers. FHIR has a direct support for RESTful architectures for managing the FHIR Resources.

The philosophy behind FHIR is to build a base set of resources that, either by themselves or when combined, satisfy the majority of common use cases. FHIR resources aim to define the information contents and structure for the core information set that is shared by most implementations. There is a built-in extension mechanism to cover the remaining content as needed.

The latest stable release of FHIR is STU3 (Standard for Trial Use) and it was published on 19 April 2017. CarePlan [FHIR-CAREPLAN] and its associated constructs such as CareTeam, Goal and ReferralRequest are maintained as resources under the care provision domain in FHIR. The HL7 Patient Care workgroup, who has defined the most recent release of HL7 Care Plan DAM is actively participating to the activities to finalize CarePlan Resource as a part of FHIR. A high-level overview of HL7 FHIR STU3 CarePlan resource is provided in the following figures.

Name	Flags	Card.	Type	Description & Constraints
 CarePlan			DomainResource	Healthcare plan for patient or group Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
 identifier	Σ	0..*	Identifier	External Ids for this plan
 definition	Σ	0..*	Reference(PlanDefinition Questionnaire)	Protocol or definition
 basedOn	Σ	0..*	Reference(CarePlan)	Fulfills care plan
 replaces	Σ	0..*	Reference(CarePlan)	CarePlan replaced by this CarePlan
 partOf	Σ	0..*	Reference(CarePlan)	Part of referenced CarePlan
 status	?! Σ	1..1	code	draft active suspended completed entered-in-error cancelled unknown CarePlanStatus (Required)
 intent	?! Σ	1..1	code	proposal plan order option CarePlanIntent (Required)
 category	Σ	0..*	CodeableConcept	Type of plan Care Plan Category (Example)
 title	Σ	0..1	string	Human-friendly name for the CarePlan
 description	Σ	0..1	string	Summary of nature of plan
 subject	Σ	1..1	Reference(Patient Group)	Who care plan is for
 context	Σ	0..1	Reference(Encounter EpisodeOfCare)	Created in context of
 period	Σ	0..1	Period	Time period plan covers
 author	Σ	0..*	Reference(Patient Practitioner RelatedPerson Organization CareTeam)	Who is responsible for contents of the plan
 careTeam		0..*	Reference(CareTeam)	Who's involved in plan?
 addresses	Σ	0..*	Reference(Condition)	Health issues this plan addresses
 supportingInfo		0..*	Reference(Any)	Information considered as part of plan
 goal		0..*	Reference(Goal)	Desired outcome of plan
 activity	I	0..*	BackboneElement	Action to occur as part of plan + Provide a reference or detail, not both
 outcomeCodeableConcept		0..*	CodeableConcept	Results of the activity Care Plan Activity Outcome (Example)
 outcomeReference		0..*	Reference(Any)	Appointment, Encounter, Procedure, etc.
 progress		0..*	Annotation	Comments about the activity status/progress

Figure 3 HL7 FHIR CarePlan Resource - Part 1

reference	I	0..1	Reference(Appointment CommunicationRequest DeviceRequest MedicationRequest NutritionOrder Task ProcedureRequest ReferralRequest VisionPrescription RequestGroup)	Activity details defined in specific resource
detail	I	0..1	BackboneElement	In-line definition of activity
category		0..1	CodeableConcept	diet drug encounter observation procedure supply other CarePlanActivityCategory (Example)
definition		0..1	Reference(PlanDefinition ActivityDefinition Questionnaire)	Protocol or definition
code		0..1	CodeableConcept	Detail type of activity Care Plan Activity (Example)
reasonCode		0..*	CodeableConcept	Why activity should be done or why activity was prohibited Activity Reason (Example)
reasonReference		0..*	Reference(Condition)	Condition triggering need for activity
goal		0..*	Reference(Goal)	Goals this activity relates to
status	?!	1..1	code	not-started scheduled in-progress on-hold completed cancelled unknown CarePlanActivityStatus (Required)
statusReason		0..1	string	Reason for current status
prohibited	?!	0..1	boolean	Do NOT do
scheduled[x]		0..1		When activity is to occur
scheduledTiming			Timing	
scheduledPeriod			Period	
scheduledString			string	
location		0..1	Reference(Location)	Where it should happen
performer		0..*	Reference(Practitioner Organization RelatedPerson Patient CareTeam)	Who will be responsible?
product[x]		0..1		What is to be administered/supplied SNOMED CT Medication Codes (Example)
productCodeableConcept			CodeableConcept	
productReference			Reference(Medication Substance)	
dailyAmount		0..1	SimpleQuantity	How to consume/day?
quantity		0..1	SimpleQuantity	How much to administer/supply/consume
description		0..1	string	Extra info describing activity to perform
note		0..*	Annotation	Comments about the plan

Figure 4 HL7 FHIR CarePlan Resource - Part 2

HL7 FHIR is continuously evolving. As it will be elaborated in the next section, by the time we started the design and early implementation activities in C3-Cloud, the care plan model in the latest release of FHIR, which was DSTU2 published in October 2015, was limited but now the model is quite mature with the availability of STU3. We explain how we make use of the HL7 FHIR STU3 care plan related resources and how we “profile” them according to the needs of the project in the next section.

3.3. C3-Cloud Care Plan Model

C3-Cloud Care Plan Model is based on HL7 FHIR STU3 CarePlan [FHIR-CAREPLAN] resource and its associated resources. By the time SRDC started the requirements analysis, design and early user interface mock-up efforts for the C3-Cloud care plan management tools, the latest stable release of HL7 FHIR was DSTU2. DSTU2 was released in October 2015 and its care provision aspect was very limited as the main focus was on more fundamental clinical resources at those early phases of the FHIR specifications. For example, there was no CareTeam resource yet. However, the development of the next release, i.e. STU3 was already ongoing and several updates in the care provision domain was taking place. We have closely followed the most up-to-date development build of HL7 FHIR from 2016 summer to April 2017, and used the continuously updated candidate STU3 resources. This approach has enabled us to work with more improved care plan models but at the same time presented some challenges mostly due to several updates, which were sometimes not backward compatible. We have formalized our information models including both care plan models and patient clinical data models for the first time in D3.3 – Conceptual Design of the C3-Cloud Architecture [D3.3] by Month 8 of the project (December 2016), and by that time STU3 release was close to completion. There have been some minor updates at the beginning of 2017 and finally the STU3 release of HL7 FHIR became official on 19 April 2017. We have fixed the basis of patient data and care plan data models to HL7 FHIR STU3 after this release, and agreed not to change it in the rest of the project timeline to enable stable implementations.

HL7 FHIR CarePlan and associated resources are not used directly as they are in the C3-Cloud project. The profiling methodology of HL7 FHIR has been followed to restrict and refine the generic resources according to the care plan management needs of the C3-Cloud project. The following steps have been applied to create the C3-Cloud HL7 FHIR profiles:

- Some new attributes based on the needs of C3-Cloud project are added as FHIR extensions.
- Some optional attributes that are not needed in C3-Cloud are discarded.
- Cardinalities of attributes are restricted whenever possible, e.g. from 0..* to 1..1 or 1..*
- Types of attributes are restricted whenever possible, e.g., from Reference(Any) to Reference(Observation).
- The value sets of coded attributes are reviewed and updated when necessary with either international code systems like WHO ATC or locally defined value sets.

The C3-Cloud profiles, for each HL7 care plan related resource, are presented in the following sub-sections. It should be noted that further resources from the HL7 FHIR STU3 specification are used in the C3-Cloud project. Resources that are directly related with patient clinical data, such as Condition, Observation (lab results, vital signs, etc.), Procedure, AllergyIntolerance, Encounter, Patient and Practitioner are maintained by WP6 – Interoperability Middleware; and resources that are directly related with patient empowerment such as Questionnaire and QuestionnaireResponse are maintained by WP5 – Patient Empowerment Platform in the C3-Cloud project. Hence, these resources are not presented here again.

A limited exemplar CarePlan bundle, used as test data in the C3-Cloud project, is provided as appendix in Section 9.

3.3.1. CarePlan

The main entry point resource to represent an integrated care plan both inline and by providing references to other resources.

Attribute	Cardinality	Type	ValueSet / URL
identifier	1..*	Identifier	
status	1..1	code	CarePlanStatus (Required)
intent	1..1	code	CarePlanIntent (Required)

Attribute	Cardinality	Type	ValueSet / URL
category	0..1	CodeableConcept	Care Plan Category (Example). Can be fixed as "Integrated care plan" from SNOMED-CT UK Edition in C3-Cloud.
title	1..1	string	
description	0..1	string	
subject	1..1	Reference (Patient)	
period	1..1	Period	
author	0..*	Reference (Practitioner)	
careTeam	1..1	Reference (CareTeam)	
addresses	0..*	Reference (Condition)	
supportingInfo	0..*	Reference (Observation)	
goal	0..*	Reference (Goal)	
nextReviewDate	0..1	Extension (dateTime)	
activity	0..*	BackboneElement	
outcomeCodeableConcept	0..*	CodeableConcept	Care Plan Activity Outcome (Example)
outcomeReference	0..*	Reference (Observation)	
progress	0..*	Annotation	
title	1..1	Extension (string)	http://hl7.org/fhir/StructureDefinition/careplan-activity-title
reference	0..1	Reference (Appointment CommunicationRequest DeviceRequest MedicationRequest ProcedureRequest ReferralRequest)	
detail	0..1	BackboneElement	
category	1..1	CodeableConcept	CarePlanActivityCategory (Example)
definition	0..1	Reference (Questionnaire)	
code	0..1	CodeableConcept	C3-Cloud Activity Codes
reasonReference	0..*	Reference (Condition)	
goal	0..*	Reference (Goal)	
status	1..1	code	CarePlanActivityStatus (Required)
statusReason	0..1	string	
prohibited	0..1	boolean	
scheduled	0..1	Timing Period	

Attribute	Cardinality	Type	ValueSet / URL
location	0..1	Reference (Location)	
performer	0..*	Reference (Practitioner Patient)	
product	0..1	CodeableConcept	ATC
dailyAmount	0..1	SimpleQuantity	
quantity	0..1	SimpleQuantity	
description	0..1	string	
identifier	1..1	Extension (Identifier)	
introducedBy	1..1	Extension (Reference [Practitioner])	
replacedBy	0..1	Extension (Identifier)	

3.3.2. CareTeam

Used for representing the multi-disciplinary care team of a patient composed of health professionals, social care workers and informal care givers.

Attribute	Cardinality	Type	ValueSet / URL
identifier	0..*	Identifier	
status	1..1	code	CareTeamStatus (Required)
category	0..1	CodeableConcept	CareTeamCategory (Example)
name	1..1	string	
subject	1..1	Reference (Patient)	
period	1..1	Period	
participant	1..*	BackboneElement	
role	0..1	CodeableConcept	Participant Roles (Example) --> 914 codes from SNOMED-CT
member	1..1	Reference (Practitioner RelatedPerson Patient Organization CareTeam)	
onBehalfOf	0..1	Reference (Organization)	
period	0..1	Period	
isManager	0..1	Extension (boolean)	http://www.c3-cloud.eu/fhir/StructureDefinition/isManager

3.3.3. Goal

Used for representing the intended treatment, dietary, behavioural objectives for a particular patient. Both high-level and low-level goals are represented via this Goal resource in C3-Cloud, and this categorization is provided in the category attribute.

Attribute	Cardinality	Type	ValueSet / URL
identifier	1..*	Identifier	
status	1..1	code	GoalStatus (Required)
category	1..*	CodeableConcept	GoalCategory (Example)
priority	0..1	CodeableConcept	GoalPriority (Preferred)
description	1..1	CodeableConcept	C3-Cloud Goal Codes
subject	1..1	Reference (Patient)	
start	1..1	date	
target	0..1	BackboneElement	
measure	0..1	CodeableConcept	C3-Cloud Goal Target Codes
detail	0..1	Quantity	
due	0..1	date	
statusDate	0..1	date	
statusReason	0..1	string	
expressedBy	1..1	Reference (Practitioner)	
addresses	0..*	Reference (Condition Observation)	
note	0..*	Annotation	
outcomeReference	0..*	Reference (Observation)	
title	1..1	Extension (string)	http://www.c3-cloud.eu/fhir/StructureDefinition/title
goalRelationship	0..*	Extension (complex)	http://hl7.org/fhir/StructureDefinition/goal-relationship
type	1..1	CodeableConcept	GoalRelationshipType (Preferred)
target	1..1	Reference (Goal)	

3.3.4. MedicationRequest

Used for representing a new medication prescription to a patient.

Attribute	Cardinality	Type	ValueSet / URL
identifier	0..*	Identifier	
status	1..1	code	MedicationRequestStatus (Required)
intent	1..1	code	MedicationRequestIntent (Required)
category	0..1	CodeableConcept	MedicationRequestCategory (Preferred)
medication	1..1	CodeableConcept	ATC
subject	1..1	Reference (Patient)	

Attribute	Cardinality	Type	ValueSet / URL
context	0..1	Reference (Encounter)	
authoredOn	0..1	dateTime	
requester	0..1	BackboneElement	
agent	1..1	Reference (Practitioner)	
reasonCode	0..*	CodeableConcept	C3-Cloud Problem Codes
reasonReference	0..*	Reference (Condition)	
dosageInstruction	0..1	Dosage	
note	0..*	Annotation	

3.3.5. Appointment

Used for representing a scheduled appointment, among care team members with or without involving the patient. Participants are clearly indicated. The timing can be tentative or exact.

Attribute	Cardinality	Type	ValueSet / URL
identifier	0..*	Identifier	
status	1..1	code	AppointmentStatus (Required)
serviceCategory	0..1	CodeableConcept	ServiceCategory (Example)
serviceType	0..1	CodeableConcept	ServiceType (Example)
specialty	1..1	CodeableConcept	Practice Setting Code Value Set (Preferred)
appointmentType	0..1	CodeableConcept	v2 Appointment reason codes (Preferred)
reason	0..*	CodeableConcept	Encounter Reason Codes (Preferred) -- > SNOMED-CT
priority	0..1	unsignedInt	
description	0..1	string	
start	1..1	instant	
end	0..1	instant	
created	1..1	dateTime	
comment	0..1	string	
incomingReferral	0..*	Reference (ReferralRequest)	
participant	1..*	BackboneElement	
type	0..1	CodeableConcept	
actor	0..1	Reference (Patient Practitioner RelatedPerson HealthcareService Location)	
required	0..1	code	ParticipantRequired (Required)
status	1..1	code	ParticipationStatus (Required)

Attribute	Cardinality	Type	ValueSet / URL
pertainsToGoal	0..*	Extension (Reference [Goal])	http://hl7.org/fhir/StructureDefinition/goal-pertainsToGoal

3.3.6. ReferralRequest

Used for representing a referral of the patient to a health professional, e.g. GP can refer the patient to ophthalmologist for retinography.

Attribute	Cardinality	Type	ValueSet / URL
identifier	0..*	Identifier	
status	1..1	code	RequestStatus (Required)
intent	1..1	code	RequestIntent (Required)
type	0..1	CodeableConcept	SNOMED CT Patient Referral (Example)
priority	0..1	code	RequestPriority (Required)
serviceRequested	0..*	CodeableConcept	Practice Setting Code Value Set (Example)
subject	1..1	Reference (Patient)	
occurrence	1..1	dateTime Period	
authoredOn	1..1	dateTime	
requester	1..1	BackboneElement	
agent	1..1	Reference (Practitioner)	
specialty	0..1	CodeableConcept	PractitionerSpecialty (Example)
recipient	1..*	Reference (Practitioner Organization)	
reasonCode	0..*	CodeableConcept	C3-Cloud Problem Codes
reasonReference	0..*	Reference (Condition Observation)	
description	0..1	string	
note	0..*	Annotation	
pertainsToGoal	0..*	Extension (Reference [Goal])	http://hl7.org/fhir/StructureDefinition/goal-pertainsToGoal

3.3.7. ProcedureRequest

Used for representing a request for diagnostic investigations, treatments, or operations to be performed.

Attribute	Cardinality	Type	ValueSet / URL
identifier	0..*	Identifier	
status	1..1	code	RequestStatus (Required)
intent	1..1	code	RequestIntent (Required)
priority	0..1	code	RequestPriority (Required)
category	0..*	CodeableConcept	Procedure Category Codes (SNOMED CT) (Example)

Attribute	Cardinality	Type	ValueSet / URL
code	1..1	CodeableConcept	Procedure Codes (SNOMED CT) (Example)
subject	1..1	Reference (Patient)	
occurrence	1..1	dateTime Period	
authoredOn	0..1	dateTime	
requester	0..1	BackboneElement	
agent	1..1	Reference (Practitioner)	
performerType	0..1	CodeableConcept	Participant Roles (Example)
recipient	1..*	Reference (Practitioner Organization Patient)	
reasonCode	0..*	CodeableConcept	Procedure Reason Codes (Example)
reasonReference	0..*	Reference (Condition Observation)	
note	0..*	Annotation	
pertainsToGoal	0..*	Extension (Reference [Goal])	http://hl7.org/fhir/StructureDefinition/goal-pertainsToGoal

3.3.8. DeviceRequest

Used for describing the request for the use of a medical device (e.g. glucometer, blood pressure monitor) by a patient.

Attribute	Cardinality	Type	ValueSet / URL
identifier	0..*	Identifier	
status	1..1	code	RequestStatus (Required)
intent	1..1	CodeableConcept	RequestIntent (Required)
priority	0..1	code	RequestPriority (Required)
code	1..1	Reference (Device) CodeableConcept	C3-Cloud Medical Device Types
subject	1..1	Patient	
occurrence	1..1	Period Timing	
authoredOn	1..1	dateTime	
requester	0..1	BackboneElement	
agent	1..1	Reference (Practitioner)	
performer	1..1	Reference (Patient RelatedPerson Practitioner)	
reasonCode	0..*	CodeableConcept	C3-Cloud Problem Codes
reasonReference	0..*	Reference (Condition Observation)	
note	0..*	Annotation	

3.3.9. Device

Used for representing the metadata of a medical device used by a patient. The most important attribute is the type of the device (e.g. glucometer, blood pressure monitor). If known, further details like MAC address, make and model can be provided as well.

Attribute	Cardinality	Type	ValueSet / URL
identifier	0..*	Identifier	Used for serial number when known
udi	1..1	BackboneElement	
deviceIdentifier	0..1	string	
name	0..1	string	
issuer	0..1	uri	
status	1..1	CodeableConcept	FHIRDeviceStatus (Required)
type	1..1	CodeableConcept	C3-Cloud Medical Device Types
manufacturer	0..1	string	
model	0..1	string	
version	0..1	string	
patient	0..1	Reference (Patient)	
owner	0..1	Reference (Organization)	

3.3.10. CommunicationRequest

Used solely for representing education materials in C3-Cloud.

Attribute	Cardinality	Type	ValueSet / URL
identifier	0..*	Identifier	
status	1..1	code	RequestStatus (Required)
category	0..*	CodeableConcept	CommunicationCategory (Example). The code is fixed to "instruction" to indicate educational material.
recipient	0..*	Reference (Patient)	
payload	1..*	BackboneElement	
content	1..1	Attachment	
occurrence	1..1	Period	
authoredOn	1..1	dateTime	
sender	0..1	Reference (Practitioner)	
reasonCode	0..*	CodeableConcept	C3-Cloud Problem Codes
note	0..*	Annotation	

3.3.11. Communication

Used for representing safe messages among care team members, patients and informal care givers.

Attribute	Cardinality	Type	ValueSet / URL
identifier	1..1	Identifier	

Attribute	Cardinality	Type	ValueSet / URL
basedOn	0..1	Reference (CarePlan Goal MedicationRequest ReferralRequest Appointment ProcedureRequest)	
status	1..1	code	EventStatus (Required)
category	1..1	CodeableConcept	C3-Cloud Communication Category Codes
medium	0..1	CodeableConcept	v3 Code System ParticipationMode (Example). To be fixed as "ONLINEWRIT" in C3-Cloud.
subject	0..1	Reference (Patient)	
recipient	1..*	Reference (Patient Practitioner RelatedPerson)	
recipientStatus	1..1	Extension (code)	http://www.c3- cloud.eu/fhir/StructureDefinition/recipientStatus
sent	1..1	dateTime	
sender	1..1	Reference (Device Patient Practitioner RelatedPerson)	
payload	1..*	BackboneElement	
content	1..1	string Attachment	
title	1..1	Extension (string)	http://www.c3- cloud.eu/fhir/StructureDefinition/title
senderStatus	1..1	Extension (code)	http://www.c3- cloud.eu/fhir/StructureDefinition/senderStatus
isRead	0..1	Extension (boolean)	http://www.c3- cloud.eu/fhir/StructureDefinition/isRead
isNoReply	0..1	Extension (boolean)	http://www.c3- cloud.eu/fhir/StructureDefinition/isNoReply
isUrgent	0..1	Extension (boolean)	http://www.c3- cloud.eu/fhir/StructureDefinition/isUrgent
head	0..1	Extension (Reference [Communication])	http://www.c3- cloud.eu/fhir/StructureDefinition/head
parent	0..1	Extension (Reference [Communication])	http://www.c3- cloud.eu/fhir/StructureDefinition/parent

Attribute	Cardinality	Type	ValueSet / URL
careTeam	0..1	Extension (Reference [CareTeam])	http://www.c3-cloud.eu/fhir/StructureDefinition/careTeam
label	0..*	Extension (string)	http://www.c3-cloud.eu/fhir/StructureDefinition/label

4. IMPLEMENTATION OF THE PCPDP

4.1. Architectural Design of the PCPDP

The initial architectural design of the Personalised Care Plan Development Platform in D3.3 is depicted in Figure 5 [D3.3]. As explained in the first section of this deliverable, PCPDP has been positioned as a sub-component of the C3DP starting from the architectural design phase of C3-Cloud. Therefore, PCPDP design is merged with the overall C3DP design. Further details of the C3DP implementation, especially the integrations with the other C3-Cloud software components like Technical Interoperability Suite (TIS) and Patient Empowerment Platform (PEP) will be presented in D7.4, due Month 24.

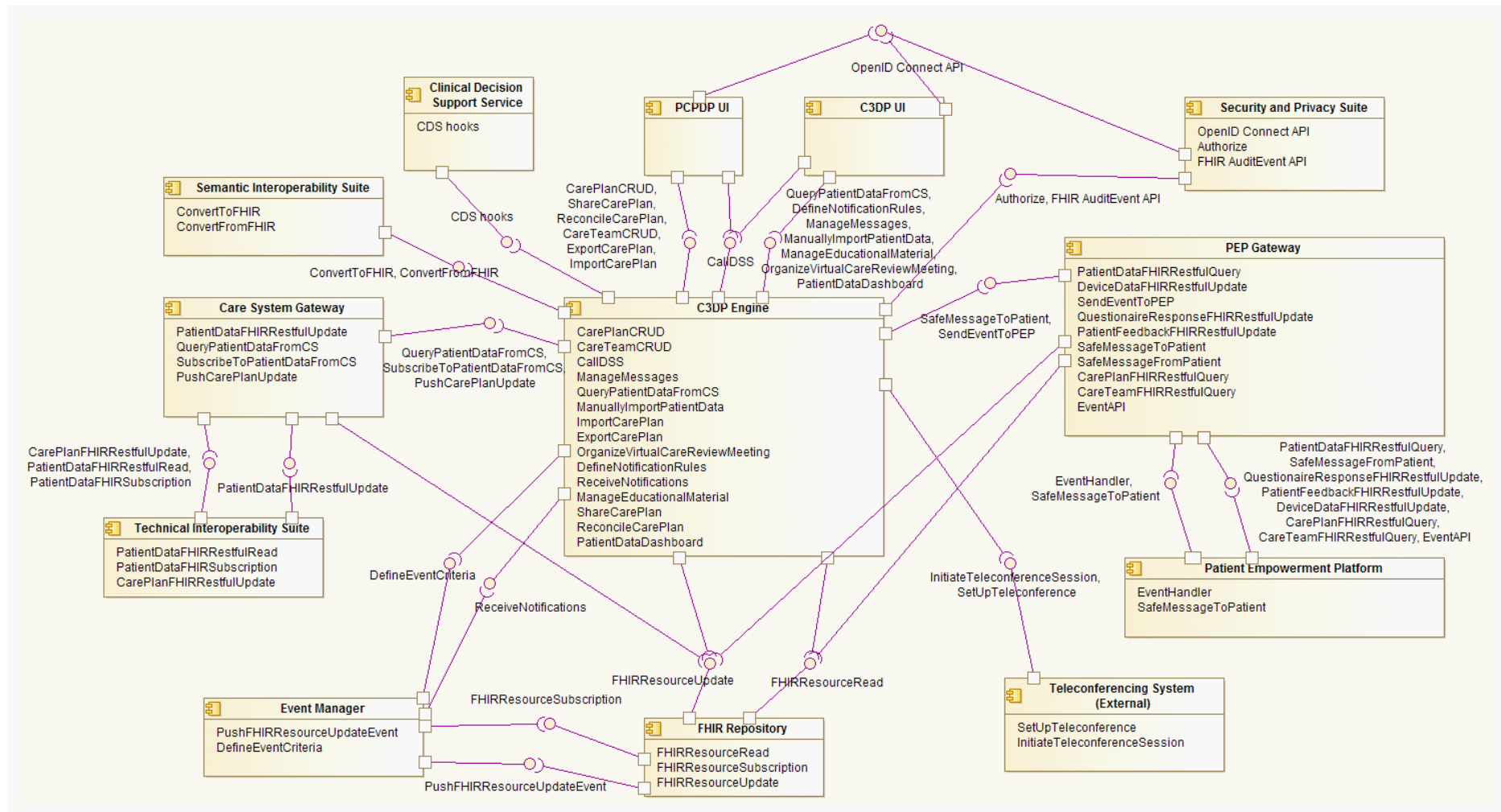


Figure 5 C3DP Component Diagram in D3.3

4.2. Implementation Details

The main sub-components of the Coordinated Care and Cure Delivery Platform (C3DP), which are involved directly in care plan management, are explained in this section.

C3-Cloud FHIR Repository

A foundational sub-component of the C3DP is the C3-Cloud FHIR Repository, which acts as the holistic data repository for existing clinical data of the patients and newly created care planning related data. SRDC provides its HL7 FHIR® compliant secure health data repository product named onFHIR [ONFHIR] for free for this purpose.

onFHIR is implemented in pure Scala and it outperforms the major publicly available FHIR repositories in terms of read and write performance. MongoDB [MONGODB] is preferred as the database. It supports both DSTU2 and STU3 releases of HL7 FHIR, and it is highly configurable according to the needs of specific projects, as demonstrated in the C3-Cloud project. For example, it is possible to introduce project specific FHIR profiles in the repository and enforce profile validation; or implement project specific FHIR operations as add-ons. onFHIR was tested successfully at the 15th FHIR Connectathon in Madrid on 6-7 May 2017. onFHIR also outperforms almost all other FHIR repositories in terms of compliance to the FHIR API and the number of supported resources / interactions in the open source FHIR testing server Crucible [CRUCIBLE] and open access testing as a service product Touchstone [TOUCHSTONE].

A public deployment of SRDC onFHIR Repository that is used for testing and development purposes in C3-Cloud is available since April 2017 at <http://app.srdc.com.tr/c3cloud/fhir>.

C3DP Web Application

C3DP Web Application is the main end-user interfacing component that enables users to manage the care plans of their patients. It is a rich client-side Web application implemented with Angular framework [ANGULAR]. It depends on some external packages like ng-fhir [NG-FHIR] as a FHIR client and Socket.IO [SOCKET-IO], as a client to subscribe to events from the C3DP Event API. Semantic UI is preferred as the CSS design framework [SEMANTIC-UI]. Responsive design principle is followed to support not only large screens of computers, but also screen sizes of tablets. A clean object-oriented model of the care plan and corresponding resources like conditions, observations, goals, activities, etc., is being maintained in Typescript. Angular framework and the external packages are kept up-to-date to prevent any conflict. A public demo of the C3DP Web application is available at <http://app.srdc.com.tr/c3dp> since September 2017.

CDS Client

Clinical Decision Support (CDS) Client is responsible for communication with the CDS services that are implemented as REST services compliant with the CDS Hooks specification [CDS-HOOKS]. CDS Client has been implemented as a custom FHIR operation on top of the C3-Cloud FHIR Repository. It has access to the MongoDB database of the C3-Cloud FHIR repository to collect prefetch data that are required by the CDS services. It maintains the configuration of each CDS service (e.g., for blood pressure management, blood glucose management) such as the service endpoint and the required patient data. When a health professional calls CDS services for getting personalized goal and activity recommendations for a specific patient, C3DP Web application forwards the request to the CDS Client, which then populates the required patient data from the C3-Cloud FHIR Repository and prepares the CDS Hooks request, sends the request to the corresponding CDS service(s), compiles the responses from the CDS services and provides them back to the C3DP Web Application.

C3DP Event API

C3DP Event API is a component that provides real-time notifications to inform users or the system itself. It is implemented with Node.js [NODEJS] using Express web application framework [EXPRESS] as REST API and Socket.IO for real-time notifications. Clients (C3DP Web Application or PEP) subscribe to the events by sending a subscribe event to the Socket.IO server in the Event API. When a

new event occurs like creating or updating a care plan, the client sends the details of this event to the C3DP Event API and the request is handled by Express routes. Then, C3DP Event API makes the necessary operations and notifies the subscribed clients back via Socket.IO and stores the notifications in the C3-Cloud FHIR Repository. Offline users can access these notifications later in their next login.

C3DP Event API has also an endpoint to handle events related to the Patient Empowerment Platform (PEP). These are also handled using Express and then the event is pushed to the PEP Event API with a REST call. Events that come from PEP are also sent as notifications to the C3DP clients via Socket.IO, if relevant.

4.3. User-centred Design Process

SRDC as the leader of Task 7.3 has started user-centred design activities even before the official start date of the task. Firstly, in parallel with requirements analysis and architecture design activities in WP3, SRDC started designing mock-up graphical user interfaces for PCPDP along with the C3DP during summer 2016. The complete set of mock-up interfaces was demonstrated to the whole consortium for the first time in SWFT pilot site visit in September 2016. Then, all partners, especially the end-user partners OSAKIDETZA, RJH and SWFT analysed the interfaces in detail in two rounds, with the involvement of actual clinical experts to use the final application. SRDC updated the mock-ups by applying the suggestions, and then started the implementation of the actual Web application. All the mock-ups are still accessible in the interactive digital product design platform InVision: <https://projects.invisionapp.com/share/BF9O8BO54#/screens>

In order to demonstrate how the initial mock-ups have evolved into the final product, the basic care plan view is provided below first as a mock-up interface in Figure 6 and then as the final Web application interface in Figure 7.

C3Cloud Care Management


Welcome Anna Svensson

Home

My Patients

Inbox

SvenKarlsson



Sven Karlsson

Age 67

Born on 23.06.1949

Kyrkgatan 18

Östersund, Sweden

0046 063-19 72 00

sven.karlsson@gmail.com

Care Coordinator

Dr. Anna Svensson

0046 065-48 67 40

anna.svenson@regionj.h.se

QuickView

Care Plans

Clinical Documents

Manage Notifications

Care Plans / Management of Hypertension & Diabetes

History

Reconcile

Save and Share

Export

Close

Status: Active

Authors: Dr. Anna Svensson

Related Encounters: Hypertension-15/03/2013

Related Careplans: Hypertension-Replaced

Period: 21/05/2014+

Erik Larsson

Diabetes-21/05/2014

Related Educational Material (MDT): select

Last modified: 13/06/2015

Description: Textual description of the Care Plan..

Next Review:

Category: integrated care plan

Related Educational Material (Patient): select

Health Concerns Addressed

Re-Use Care Plan Templates

☒ Hypertension
 ☒ Diabetes Mellitus, Type 2

Goals Targeted

☐ Increase Physical Activity
 ☐ Improve Hemodynamic stability
 ☐ Decrease HbA1c to ...

! View new patient feedback

behind-target

in-progress

! View new results from care systems

achieved

Activities

☐ Monitor Blood Pressure
 ☐ Log daily insulin injection and medication intake
 ☐ Daily exercise, mild

Monitor results

Monitor results

View recent patient feedback

Care Team

Care Barriers/Patient Status

Notes

Figure 6 Basic Care Plan View Mock-up Design

The screenshot displays the C3-Cloud web application interface. The top navigation bar includes links for Home, My Patients, Activities, Messages, and a Logout button. A sidebar on the left shows the patient's profile for Sven Karlsson, including age (76), gender (male), email, phone, and address. Below the profile are links for Medical Summary, Chronic Disease Profile, Care Plan, Care Team, Previous Care Plans, Clinical Docs, Notifications, and Safe Message.

The main content area is divided into two sections: 'Goals' and 'Activities'.

Goals Section: A table lists various goals for the patient, all with a 'Sustaining' status. The goals include Eye Disease Screening, Avoid Microangiopathy, Decrease Non-HDL Cholesterol, Keep blood pressure under control, Keep HbA1c under 6.5% mmol/l, and Comply with dietary restrictions. Each goal has a start date ranging from 13 Aug 1999 to 21 Jul 2009.

Title	Status	Category	Start Date
Eye Disease Screening	Sustaining	Safety	21 Jul 2009
Avoid Microangiopathy	Sustaining	Safety	21 Jul 2009
Decrease Non-HDL Cholesterol	Sustaining	Safety	21 Jul 2009
Keep blood pressure under control	Sustaining	Safety	21 Jul 2009
Keep HbA1c under 6.5% mmol/l	Sustaining	Safety	21 Jul 2009
Comply with dietary restrictions	Sustaining	Dietary	13 Aug 1999

Activities Section: A table lists various activities assigned to the patient, all with a start date. The activities include Annual Control visit with Dr. Anna Svensson, 6 monthly Control visit with Dr. Anna Svensson, 3 monthly Control visit with Dr. Anna Svensson, and Diabetes Education Encounter with Diabetes Nurse Erik Larsson.

Title	Start Date	Actions
Annual Control visit with Dr. Anna Svensson	20 Jul 2010	[Icons]
6 monthly Control visit with Dr. Anna Svensson	20 Jan 2010	[Icons]
3 monthly Control visit with Dr. Anna Svensson	20 Oct 2009	[Icons]
Diabetes Education Encounter with Diabetes Nurse Erik Larsson	30 Jul 2009	[Icons]

Figure 7 Final Care Plan View in the Web Application

As of April 2017, i.e. only by the 3rd month of the task and the end of the 1st year of the project, it was already possible to display all components of an existing personalised care plan and also a structured summary of the patient data via the C3DP Web Application, based on manually crafted test patient and care plan data, which is another user-centred design activity to be presented in the upcoming parts. Since then, the C3DP Web Application has been presented to the whole C3-Cloud team, especially to the clinical experts from the pilot sites several times in face-to-face consortium meetings and in dedicated teleconference sessions to work through the creation and update of a care plan from scratch in collaboration with the clinical team at pilot sites. The aim is to collect feedback from the users as soon as possible when a new function is implemented, and improve it according to the received feedback immediately. A public deployment of C3DP Web Application is up and running at SRDC servers at <http://app.srdc.com.tr/c3dp/> since September 2017 with several updates.

Another main branch of user-centred design activity was the creation of reference test care plan data and corresponding patient data. SRDC has prepared a comprehensive care plan example to be used as reference data. The first complete draft was based on the Swedish story board provided in D8.1, with further updates, modifications and assumptions. SRDC prepared this first draft in an Excel sheet (Figure 8) that was compliant with the FHIR CarePlan resource but skipping the low-level details for the sake of clinical partners. The aim of this activity was three-fold:

- Improve communication and mutual understanding between technical and clinical partners
- Discuss pieces of required data in detail, by skipping the technical presentation syntax (e.g. HL7 FHIR, XML, JSON)
- Facilitate technical implementation work

Health Concern					
identifier	c-001	c-002	c-003	c-004	c-005
name	Hypertension	Provision for improving hea	Hypertension with complica	Diabetes type 2	Risk of deterioration of skin
code.code	I10	00162	I13.9	E11.2	00047
code.codedname	Essential (primary) hyperten	Provision for improving hea	Hypertensive heart and rena	Type 2 diabetes mellitus wit	Risk of deterioration of skin
code.codesystem	ICD-10	NANDA: 2015-2017	ICD-10	ICD-10	NANDA: 2015-2017
severity	moderate		moderate	moderate	
clinical status	inactive	active	active	active	active
start date	13/08/1999	13/08/1999	21/07/2009	21/07/2009	22/07/2009
end date	21/07/2009	-	-	-	-
asserter	Dr. Anna Svensson	Martina LC	Dr. Anna Svensson	Dr. Anna Svensson	Erik Larsson
Patient Status Observation					
identifier	r-001	r-002			
name	Cognitive impairment	Functional impairment (ADL)			
code.code	273617000	273302005			
code.codedname	Mini-mental state examinatio	Barthel index			
code.codesystem	SNOMED-CT	SNOMED-CT			
status	final				
date	21/07/2009	21/07/2009			
value	27	18			
reference range	0-30	0-20			
performer	Dr. Anna Svensson	Dr. Anna Svensson			
Care Barrier					
identifier	b-001				
code.code	75281-6				
code.codedname	Personal belief				
code.codesystem	LOINC				
status	final				
date	21/07/2009				
value	Patient refuses all blood transfusion and administration of primary blood components and minor fractions				
performer	Dr. Anna Svensson				
Goal					
identifier	g-001	g-002	g-003	g-004	g-005
category	safety	dietary	safety	safety	safety
					Structural indemnity and normal physiological function of the skin and mucous membranes
title	Keep blood pressure under control	Comply with dietary restrictions	Keep HbA1c under 6.5% mmol/l	Keep blood pressure under control	
description.code	135840009	385769008	51798006	135840009	1101
		Encouragement of			

Figure 8 An excerpt from the reference care plan data Excel sheet

In December 2016, SRDC shared the early drafts with technical partners. MEDIXINE and SRDC improved it in several iterations, and by January 2017, v0.4 was shared with all partners. Till the end of March 2017, three dedicated teleconferences and several email exchanges took place for discussing and updating the care plan example. All pilot site partners, i.e. OSAKIDETZA, RJH and SWFT, analysed the example in detail with the involvement of clinical experts, discussed the open issues and provided improvements. OSAKIDETZA proposed new activities and goals from the nursing perspective. After agreeing on the maturity of the example, in April 2017 SRDC modelled it in HL7 FHIR STU3 and exchanged with the technical partners. A subset of the reference care plan example is provided as appendix in Section 9.

Since then, this reference care plan data has been used in all implementation and integration activities with several improvements and additions (e.g., with the introduction of questionnaires). It also formed the basis of the first complete and realistic storyboard that was again developed by SRDC to facilitate development and integration activities among C3-Cloud partners. This storyboard includes complete patient data represented as FHIR resources and detailed execution steps to create a personalised care plan and share it with both the care team via C3DP and also the patient via PEP. The details of the storyboard will be provided in D7.4.

5. PCPDP INTEGRATION

Personalised Care Plan Development Platform (PCPDP) as a sub-component of the Coordinated Care and Cure Delivery Platform (C3DP) is integrated with a majority of the other C3-Cloud software components. In this section, such integrations are briefly explained while the details of all integration activities among C3-Cloud software components will be presented in the dedicated deliverable of WP7, i.e. D7.4 - C3-Cloud Coordinated Care and Cure Delivery Platform.

5.1. Integration with CDSM

C3DP has been integrated with the Clinical Decision Support (CDS) services that are developed within the scope of Task 7.2. Integration with the C3-Cloud CDS services enable presentation of personalised goal recommendations (e.g., blood pressure targets, dietary targets) and intervention recommendations (medication therapies, guidance on contradicting medications, laboratory test requests, referrals to specialists, scheduling follow-up timings) to the care team members. CDS Hooks specification [CDS-HOOKS] is used as the technical interface in this integration.

5.2. Integration with TIS

In the C3-Cloud architecture, the Technical Interoperability Suite (TIS) is responsible for integration with the local EHR/EMR systems of the pilot sites for retrieving the relevant parts from the medical records of the patients and providing them to the C3-Cloud FHIR Repository after handling the structural transformation (e.g., from HL7 CDA to HL7 FHIR) and code mapping activities by using the Semantic Interoperability Suite (SIS). All patient data provided by the TIS in the C3-Cloud FHIR Repository are used by the C3DP for display to the care team members and also during calls to the CDS services. Similarly, TIS is responsible for providing care plan data from the C3DP back to the local systems of the pilot sites. HL7 FHIR API [FHIR] is used as the technical interface in the integration between TIS and C3-Cloud FHIR Repository. All the interactions between the C3DP Web Interface and the C3-Cloud FHIR Repository also take place via the HL7 FHIR API.

5.3. Integration with PEP

In C3-Cloud, C3DP is the Web application for care plan management only by the professionals (i.e. health professionals and social care workers), while patient and informal care giver participation in the care planning process is enabled via the Patient Empowerment Platform (PEP) Web application that is provided by WP5. Two-way data exchange between C3DP and PEP has been implemented for sharing of the care plan from the C3DP side to the PEP side; and retrieving patient observations (e.g., meal photos, medical device measurements), questionnaire responses and feedback regarding the assigned activities from the PEP to C3DP. There is also two-way asynchronous safe message exchange implemented between C3DP and PEP. Corresponding data exchange takes place via the C3-Cloud FHIR Repository and hence HL7 FHIR API is used as the technical interface in this integration. There is also an event API integration between C3DP and PEP for enabling real time events and notifications (e.g., a new message received, a questionnaire response is available).

5.4. Integration with SPS

Security and Privacy Suite (SPS) is responsible for authentication and authorisation of Care Team Members while they are managing personalised care plans of patients and accessing sensitive personal data; and ensuring that all data exchange within and across C3-Cloud software components is encrypted and properly auditable in the overall C3-Cloud architecture. Integration of the C3DP with the SPS enables authentication of the care team members via the OpenID Connect 1.0 specification [OPENIDCONNECT] and access control enforcement of all access to patient data maintained in the C3-Cloud FHIR Repository by complying with the Smart App Authorization specification [SMART-APP-AUTZ], which is also based on OpenID Connect 1.0 and OAuth 2.0 [OAUTH].

6. DESCRIPTION OF THE DEMONSTRATOR

6.1. Demonstration steps

C3DP is deployed and accessible from: <http://app.srdc.com.tr/c3dp>. For demonstration purposes, the following access credentials that belong to a fictional GP user Dr. Anna Svensson can be used:

username: anna_svensson

password: password

The demonstration involves a complete series of all the possible functionalities that a care team member (a health professional or a social care worker) can perform. This demonstration description will form the basis of the training materials that will be provided to the pilot site users.

6.1.1. User login

When a user (health professional or social care worker) opens the C3DP via a modern Web browser, thanks to the integration with the C3-Cloud Security and Privacy Suite (SPS), she is forwarded to the login page (Figure 9). If the Identity Provider (IdP) system of the user is integrated with the SPS, as in the case of OSAKIDETZA and RJH, then she uses her regular business credentials to login and when she is already logged in to her EHR software, it is not necessary to re-login (i.e. single sign-on). If regional IdP of the user is not integrated with SPS, then she uses the credentials provided by the OpenID Connect 1.0 compliant IdP of C3-Cloud, which is part of the SPS.

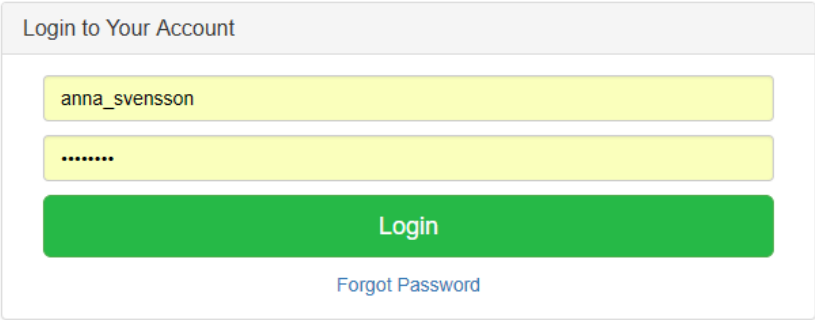



Figure 9 C3DP login screen

If it is the first time Anna Svensson (GP user in this scenario) is using the application or the “Remember my decision” option is not checked in an earlier login, she will be asked for consent to use her account in C3DP app (Figure 10).

C3DP needs authorization to access following information:



Client Name:

Human readable client name


Contacts:

List of contacts for administrators of this client

Terms of Service Uri: [Terms of Service](#)
URL for the Terms of Service of this client, will be displayed to the user

Policy Uri: [Privacy Policy](#)
URL for the Privacy Policy of this client, will be displayed to the user

Access To

- ☒  **basic profile information**
- ☒  **log in using your identity**
- ☒  **access rights for health data**

Accepting authorization request will redirect you to
<http://localhost:4200/home>

Accept
Deny

☐ Remember my decision

Figure 10 The user authorizes C3DP to use her account

6.1.2. Home Screen

After logging in, the user is redirected back to the C3DP and she is welcomed via the home screen (Figure 11). This screen is like a dashboard that consists of navigation menus and information blocks to show the active patients of the user, incoming activities, new messages and notifications.

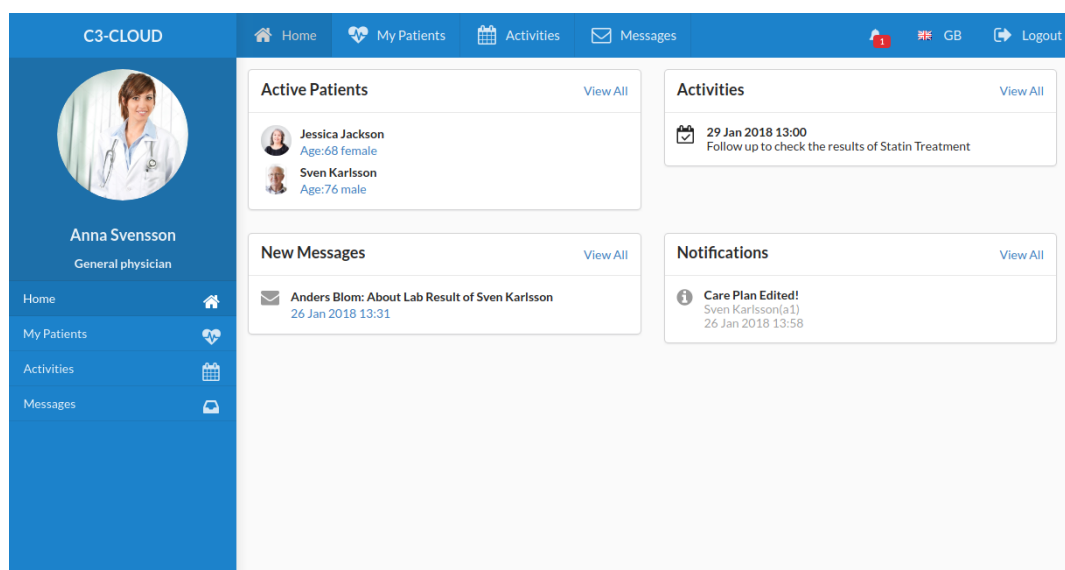


Figure 11 Home Screen of C3DP

6.1.3. Listing patients with active care plans

If the user is part of a patient's active care team, she can see the patient listed in My Patients page (Figure 12). She can navigate to care plan details or medical summary of a patient by clicking on the patient card. Furthermore, she can find other patients by using the search bar and create a care plan (if there is none) or request to join the care team of that patient (if there is already an active care plan of the patient).

The screenshot shows the 'My Patients' page for Anna Svensson, a General physician. The page lists two patients with active care plans:

Patient Name	ID	Age	Gender	Active Conditions	Active Care Plans
Jessica Jackson	14752348-1360	68 years (06 Mar 1950)	female	<ul style="list-style-type: none"> Hypertensive heart and renal disease, unspecified Type 2 diabetes mellitus with renal complications Unspecified kidney failure 	<p>Title</p> <p>Integrated care plan for hypertension, diabetes type II and renal failure</p> <p>Last Update</p> <p>26 Jan 2018 16:25</p> <p>Next Review</p> <p>20 Oct 2009</p>
Sven Karlsson	19420816-1010	75 years (16 Aug 1942)	male	<ul style="list-style-type: none"> Unspecified kidney failure Type 2 diabetes mellitus with renal complications Hypertensive heart and renal disease, unspecified Provision for improving health management 	<p>Title</p> <p>Integrated care plan for hypertension, diabetes type II and renal failure</p> <p>Last Update</p> <p>26 Jan 2018 15:24</p> <p>Next Review</p> <p>20 Oct 2009</p>

Figure 12 Active Patients of Anna Svensson

6.1.4. Initiating a Care Plan

6.1.4.1. Searching for the Patient

To create a new care plan for a patient, the user should find the patient using search bar and then click the “new” button to start initialization of the care plan (Figure 13).

Figure 13 Search Patient

6.1.4.2. Reviewing Medical Summary

After selecting the patient, the user will be asked to review the medical summary before initiating the care plan (Figure 14). She can see the conditions, medications, allergies, observations, etc. of the patient grouped as sections. All the patient data that are retrieved from the local EHR/EMR systems, transformed into FHIR resources and put into the C3-Cloud FHIR Repository by the C3-Cloud Interoperability Suite are shown here. The user can also inspect quantified observations like vital signs as charts (e.g., Figure 15).

Figure 14 Review Medical Summary

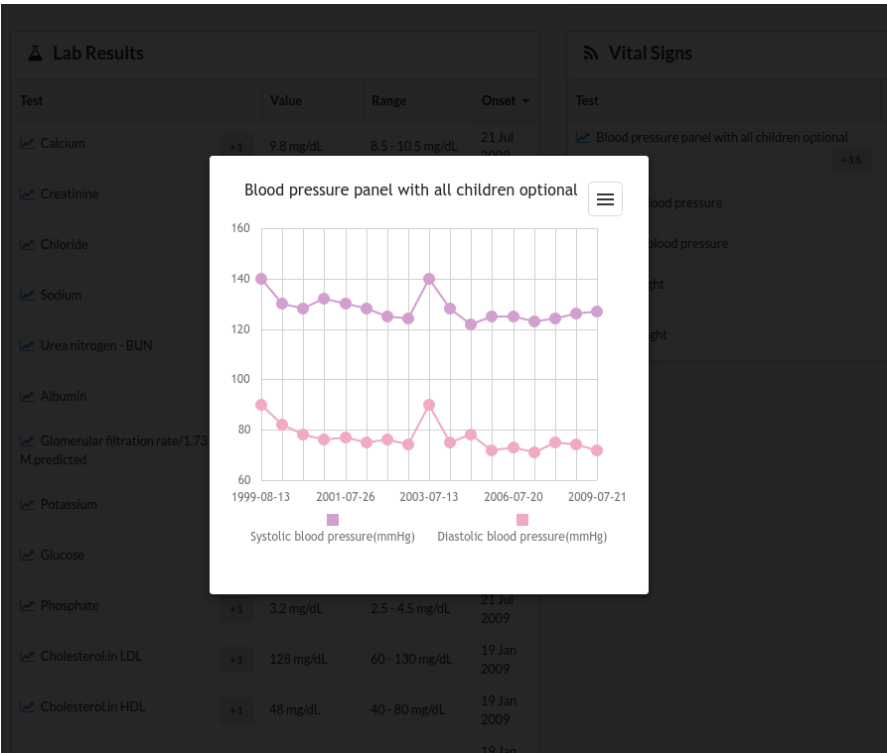


Figure 15 Blood Pressure Observations over Time

6.1.4.3. Care Team Initialization Form

When the user checks the medical summary and clicks to continue, a form will be shown to set the metadata of the care plan (Figure 16). The user should give a title and set the major conditions that will be addressed in this care plan. New care plan will be created based on a template that will be generated according to the selected diseases. The user is also able to select the members of the care team or assign an existing care team for this care plan.

C3-CLOUD

HomeMy PatientsActivitiesMessages

1GBLogout

Philip Bergman

Patient

Age: 89 (15 Nov 1929)

Gender: male

E-mail: bergman@example.com

Phone: (643) 593 1990

Address: Hundbergsvägen 1
HALLEN 830 01 (home)

Medical Summary

Chronic Disease Profile

Care Plan

Care Team

Previous Care Plans

Clinical Docs

Notifications

Safe Message

Create New Care Plan

Title

New Care Plan of Philip Bergman

Diseases

Diabetes

Heart Failure

Renal Failure

Depression

Addressed Conditions

☒ Essential (primary) hypertension

☒ Unspecified kidney failure

☒ Type 2 diabetes mellitus with renal complications

Care Team

☐ Assign existing care team

Create New Care Team

Add New Member

Search

Anna Svensson, Practitioner

Role

Code

Organization

Search

Manager

☒ Set as manager

Remove

Create & Continue

Figure 16 Care Plan Form

6.1.4.4. Reviewing and Updating Chronic Disease Profile

Finally, the user will be expected to review and fill if there are missing data in the chronic disease profile of the patient (Figure 17). Chronic Disease Profile is a bit different than the Medical Summary view; here all the clinical concepts that are required by the Clinical Decision Support (CDS) services as input are collected and shown the user. The patient might already have some clinical data from the original EHR systems that match with these clinical concepts. In that case, matching clinical concepts are automatically filled and the user is not able to alter the value. For the rest, the user can update the values with recent data, as some data might be missing in the local EHR systems. The rationale for the Chronic Disease Profile is the need to have the final confirmation of the health professionals for any patient data that will be forwarded to CDS services. After the user checks and confirms the disease profile, a new care plan will be created.

D7.3 Version 1.0, dated 28 February 2018

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i Please fill the form carefully and click save to activate care plan.

Medical Summary Profile template for Type 2 Diabetes

> Conditions

Name	Value
Type 1 diabetes	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Type 2 diabetes	<input checked="" type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Unknown
Hypertension	<input checked="" type="radio"/> Yes <input type="radio"/> No <input type="radio"/> Unknown
Essential (primary) hypertension	<input type="text"/>
Chronic kidney disease	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Micro-vascular	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Cardiovascular disease	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Rheumatoid arthritis	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Atrial fibrillation	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Symptomatic hyperglycemia	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Cardiac failure	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Alcoholism with complications	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Hepatic impairment	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Diabetic ketocodosis	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown

> Lab Results

Name	Value
Albumin secretion	<input type="text"/> Quantity <input type="text"/> mg/l ▾
HbA1c	<input type="text"/> Quantity <input type="text"/> mmol/l ▾
eGFR	<input type="text"/> Quantity <input type="text"/> mL/min ▾
Cholesterol	<input type="text"/> Quantity <input type="text"/> mg/dL ▾
HDL	<input type="text"/> Quantity <input type="text"/> mg/dL ▾
LDL	<input type="text"/> Quantity <input type="text"/> mg/dL ▾
Aspartate aminotransferase	<input type="text"/> Quantity <input type="text"/> U/L ▾

> Medications

Name	Value
Atorvastatin	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Blood pressure treatment	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Treatment with risk of hypoglycemia	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown
Previous ulceration therapy	<input type="radio"/> Yes <input type="radio"/> No <input checked="" type="radio"/> Unknown

Figure 17 Chronic Disease Profile of the Patient

6.1.5. Care Plan Management

The main interface for the care team members is the care plan management module of the C3DP (Figure 18). The user can track and update the progress of patients on assigned goals and activities or create new ones. Clinical Decision Support (CDS) services are also integrated in this module to help the user in the management of the care plan by suggesting creating or cancelling some goals, activities (medication request, lab test request, device usage request, referral to a specialist, the next planned appointment, etc.) and education materials.

C3-CLOUD Home My Patients Activities Messages

Sven Karlsson
Patient
Age: 76 (16 Aug 1942)
Gender: male
E-mail: svenkarlsson@example.com
Phone: (360) 555 1212
Address: Solldidavägen 29
Östersund 831 43 (home)

Medical Summary +
Chronic Disease Profile
Care Plan
Care Team
Previous Care Plans
Clinical Docs
Notifications
Safe Message

Goals + Add New Goal

Display Inactive Goals

Title	Status	Category	Start Date
Eye Disease Screening	Sustaining	Safety	21 Jul 2009
Avoid Microangiopathy	Sustaining	Safety	21 Jul 2009
Decrease Non-HDL Cholesterol	Sustaining	Safety	21 Jul 2009
Keep blood pressure under control	Sustaining	Safety	21 Jul 2009
Keep HbA1c under 6.5% mmol/l	Sustaining	Safety	21 Jul 2009
Comply with dietary restrictions	Sustaining	Dietary	13 Aug 1999

Activities + Add New Activity

Assigned To: Anyone Me Care Team Patient

Display Inactive Activities

Title	Start Date	Actions
Annual Control visit with Dr. Anna Svensson	20 Jul 2010	
6 monthly Control visit with Dr. Anna Svensson	20 Jan 2010	
3 monthly Control visit with Dr. Anna Svensson	20 Oct 2009	
Diabetes Education Encounter with Diabetes Nurse Erik Larsson	30 Jul 2009	

Figure 18 Care Plan View

6.1.5.1. High-Level Goals

The goals, activities and education materials in an integrated care plan are grouped under some high-level goals in the C3-Cloud project. These high level goals are defined according to the main sub-sections of the chronic disease management clinical guidelines in order to be more context aware, such as blood pressure management, blood glucose management, diet & life style management. We actually implemented first a global list of goals and activities, but in that case it became really hard to associate the CDS recommendations with the care planning of the patient. In other words, it was not clear which recommendation was being done for which purpose. Now, each tab at the top of the interface as shown in Figure 19 refers to a high-level goal, except the first one which still enables to list all goals, activities and education materials in a single list.

Each high-level goal is assigned one or more CDS services. The clinical data that are required by these services as input data are shown at the top of each high-level goal to be checked by the user. The clinical data represented here is a subset of the data provided in the “Chronic Disease Profile” view. This functionality has been implemented again later on based on experience with the single Chronic Disease Profile view, which can become quite long and hard to be associated with the purpose of need.

Following the required patient data section, the goals, activities and education materials associated with the corresponding high-level goal are listed. At the bottom of each high-level goal, there is a button to retrieve recommendations from the associated CDS services.

C3-CLOUD

Home


My Patients

Activities

Messages

GB

Logout



Sven Karlsson

Patient

Age: 76 (16 Aug 1942)

Gender: male

E-mail: svenkarlsson@example.com

Phone: (360) 555 1212

Address: Solldenvägen 29
Östersund 831 43 (home)

Medical Summary

Chronic Disease Profile

Care Plan

Care Team

Previous Care Plans

Clinical Docs

Notifications

Save Message

All

Lipid Management

Diet & Lifestyle

Patient Education

Complication Management

BP Management

Glucose Management

Patient Data

Conditions

Type 2 diabetes

☒ Yes
 ☐ No
 ☐ Unknown

Chronic kidney disease

☐ Yes
 ☐ No
 ☒ Unknown

Cardiovascular disease

☐ Yes
 ☐ No
 ☒ Unknown

Medications

Atorvastatin

☐ Yes
 ☐ No
 ☒ Unknown

Lab Results

eGFR

+2

Quantity

mL/min

LDL

+2

Quantity

mg/dL

Aspartate aminotransferase (AST)

Quantity

U/L

Alanine aminotransferase (ALT)

Quantity

U/L

CRISK2

+1

Calculate

Quantity

%

Goals

+ Add New Goal

Decrease Non-HDL Cholesterol

Sustaining

Safety

21 Jul 2009

Activities

+ Add New Activity

Figure 19 ‘Lipid Management’ High Level Goal

6.1.5.2. CDS Suggestions

After a health professional checks the patient data and the status of goals and activities, she can call CDS services with the provided data by clicking “Get Suggestions” button.

C3-CLOUD

Home

My Patients

Activities

Messages

Sven Karlsson

Patient

Age: 76 (16 Aug 1942)

Gender: male

E-mail: svenkarlsson@example.com

Phone: (360) 555 1212

Address: Solldenvägen 29 Östersund 831 43 (home)

Medical Summary

Chronic Disease Profile

Care Plan

Care Team

Previous Care Plans

Clinical Docs

Notifications

Safe Message

Goals

+ Add New Goal

Display Inactive Goals

	Title	Status	Category	Start Date
	Decrease Non-HDL Cholesterol	Sustaining	Safety	21 Jul 2009

Activities

+ Add New Activity

Display Inactive Activities

Assigned To: Anyone Me Care Team Patient

	Title	Start Date	Actions
	3 monthly Control visit with Dr. Anna Svensson	20 Oct 2009	
	Have Aspartate transaminase (AST) test before 3 monthly lipid control...	18 Oct 2009	
	Have Alanine transaminase (ALT) test before 3 monthly lipid control vi...	18 Oct 2009	
	Have Lipid Panel Test before 3 monthly lipid control visit	18 Oct 2009	
	Atorvastatin 20mg	21 Jul 2009	

Education Materials

+ Add New Material

No education materials to show

Suggestions

Get Suggestions

Figure 20 CDS Segment of High-Level Goal

CDS services will respond with goal and activity suggestions that can be directly added to the care plan by the health professional or information-only cards that provide textual guidance to be considered by the health professional (Figure 21). The user can always edit the suggested goals and activities before saving them to the care plan. In the end, the ultimate authority is always the health professional.

The screenshot displays the C3-Cloud user interface. On the left is a blue sidebar with a patient profile for Sven Karlsson, including his photo, name, age (76), gender (male), email, phone, and address. Below this are links to Medical Summary, Chronic Disease Profile, Care Plan, Care Team, Clinical Docs, Notifications, and Safe Message. The main content area has a top navigation bar with Home, My Patients, Activities, and Messages. Below this, a header shows 'Atorvastatin 20mg' and the date '21 Jul 2009'. The 'Education Materials' section is currently empty. The 'Suggestions' section, titled 'Atorvastatin Recommendation: 20mg, lipid and liver transaminases tests', provides a detailed recommendation and a list of suggested items:

Suggestion	Type
Offer atorvastatin 20 mg. Add a goal to lower the non-HDL Cholestrol by %40. Appointment for control visit after 3 months. Suggestion lipid and liver transaminases tests.	
Offer Starting Statin Treatment	MedicationRequest
Statin Treatment Followup Goal	Goal
Statin Treatment Followup Appointment	Appointment
Lipid Panel Test Observation	Activity
Aspartate transaminase (AST) test	Activity
Alanine transaminase (ALT) Test	Activity

A 'Refresh Suggestions' button is located at the bottom of the suggestions list.

Figure 21 CDS Suggestions

6.1.5.3. Adding / updating a goal

The user can add goals which are suggested by the CDS services or she can create a goal from scratch manually (Figure 22) by using “Add New Goal” button in Figure 20. She can also update the existing goals by editing or cancelling them (Figure 23).

C3-CLOUD

Home


My Patients

Activities

Messages

GB

Logout



Sven Karlsson

Patient

Age: 76 (16 Aug 1942)

Gender: male

E-mail: svenkarlsson@example.com

Phone: (360) 555 1212

Address: Solldenvägen 29
Östersund 831 43 (home)

Medical Summary

Chronic Disease Profile

Care Plan

Care Team

Previous Care Plans

Clinical Docs

Notifications

Safe Message

All

Lipid Management

Diet & Lifestyle

Goals

Title

Activities

Assigned To

Anyone

Me

Care Team

Title

Diabetes Education Encounter with Di

Education Materials

High blood pressure (hypertension)

Type 2 diabetes

Suggestions

Title

Description

Code

Category

Priority

Status

Status Date

Start Date

Target

Set By

Addresses

Related Activities

Outcome(s)

Notes

Title

Description

Search

Search

Code

Search

Planned

+ Add Target

Anna Svensson

Search

Search

Search

+ Add Note

Figure 22 Creating a New Goal

C3-CLOUD

Home
My Patients
Activities
Messages
GB
Logout

Sven Karlsson

Patient

Age: 76 (16 Aug 1942)

Gender: male

E-mail:
svenkarlsson@example.com

Phone: (360) 555 1212

Address: Sollidenvägen 29
Östersund 831 43 (home)

- Medical Summary
- Chronic Disease Profile
- Care Plan
- Care Team
- Previous Care Plans
- Clinical Docs
- Notifications
- Safe Message

AllLipid ManagementDiet & Lifestyle

Patient Data

Conditions

- Ulceration
- Spreading infection
- Critical limb ischaemia
- Gangrene
- Suspicion of an acute arthropathy

Goals

ID	Title
1	Eye Disease Screening
2	Avoid Microangiopathy

Activities

Assigned To: AnyoneMeCare TeamP...

Eye Disease Screening

Title

Eye Disease Screening

Description

Monitoring Eye Disease

Code

Eye disorder Screening

Change

Category

Search

Safety

Priority

High Priority

Status

Sustaining

Status Date

21 Jul 2009

Start Date

21 Jul 2009

Target

+ Add Target

Set By

Anna Svensson

Addresses

Search

Type 2 diabetes mellitus with renal complications

Related Activities

Search

Referral for retinography

Figure 23 Editing a Goal

6.1.5.4. Adding / updating an activity

The user can add activities which are suggested by the CDS services or she can create an activity from scratch manually (Figure 24) by using “Add New Activity” button in Figure 20. The new activity can be either a basic activity or a more specific type like questionnaire, medication request, referral request or an appointment. Most activity types have common or similar attributes as presented in detail in Section 3.3, and they usually differ with a few attributes and different required fields. The form validation should be successful to be able to create an activity; when there is some missing data for a required field, the user is warned appropriately.

The screenshot shows the C3-Cloud interface. On the left, a patient profile for Sven Karlsson is visible, including his age (76), gender (male), and contact information. The main area displays the 'Create New Activity' form. The form has tabs for 'Activity', 'Questionnaire', 'Medication Request', 'Referral Request', and 'Appointment'. The 'Activity' tab is selected. The form includes fields for Title, Description, Status (set to 'Proposed'), Start Date, End Date, Service Category, Service Type, Appointment Type, Participants, Location, Outcome, and Progress. There are also buttons for 'Add Note' and 'Add New Activity'.

Figure 24 Creating New Activity

The user can also edit or complete an activity based on the progress. There are action buttons to complete or add note to the activity (Figure 25 - 1). For the periodic activities such as medical device usage once a day, there are two more action buttons to mark the activity as done or not done within the scope of the current encounter (Figure 25 - 2).

Activities			+ Add New Activity
Assigned To: Anyone Me Care Team Patient			Display Inactive Activities
Title	Start Date	Actions	
6 monthly Control visit with Dr. Anna Svensson	20 Jan 2010	1 ▶ ⊞	
Measure Blood Pressure	18 Oct 2009	▶ ⊞	
Enalapril once a day	13 Jul 2003	▶ ⊞	
Measure blood pressure weekly Systolic blood pressure: 121 mmHg (04 Dec 2017) Diastolic blood pressure: 79 mmHg (04 Dec 2017)	21 Jul 2009	2 ▶ ⊞ ✔ ✖	

Figure 25 Activities

6.1.5.5. Activities with Observations

Some activities may have related observations like meal photos, lab results or vital sign measurements. When there are associated Observation resources in the C3-Cloud FHIR Repository either provided by the patient himself via the Patient Empowerment Platform (e.g. blood glucose measurement) or by a clinical system (e.g., HbA1c result), these results are automatically matched and the latest record is shown below the corresponding activity title (Figure 26). The user can see all these observations in the activity details by clicking on the activity title.



Figure 26 Activities with Latest Observations

If the related observations of the activity are photos, they will be shown as a gallery and user will be able to enlarge the photo by clicking on it and swipe between photos. If the observations are measurements, then there will be a chart of these measurements over time.

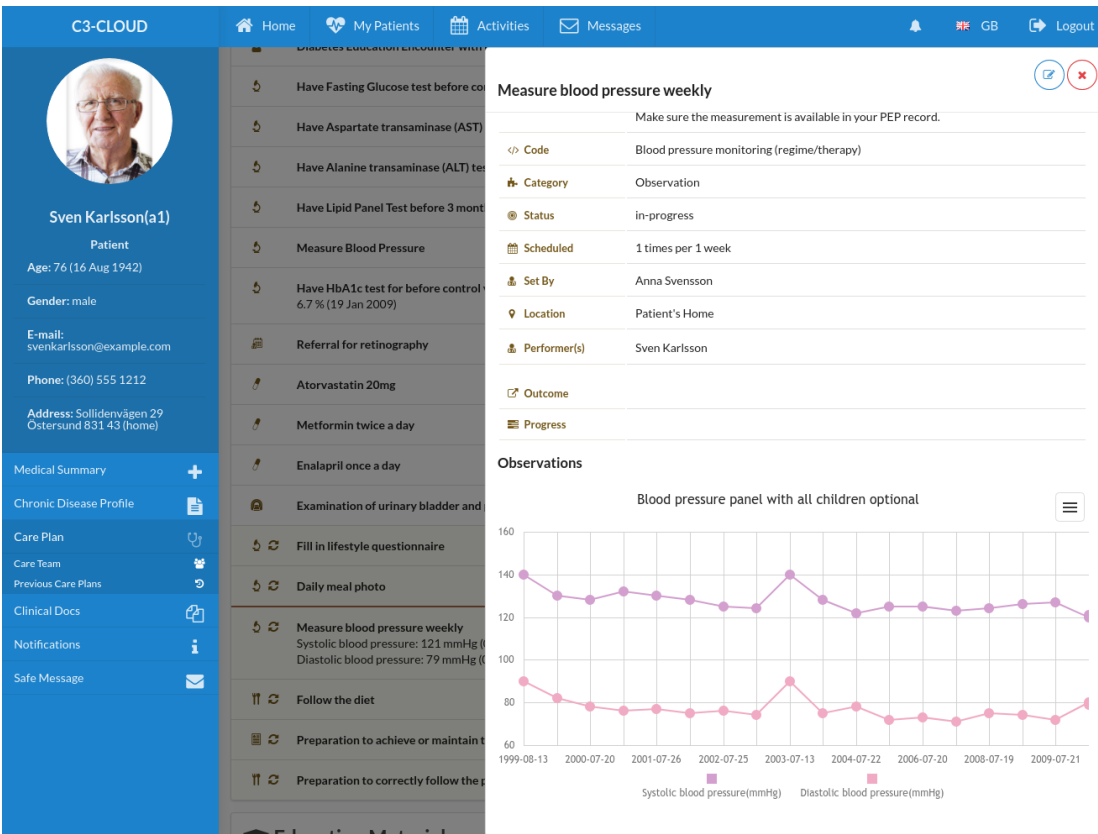


Figure 27 Activity with Blood Pressure Measurements

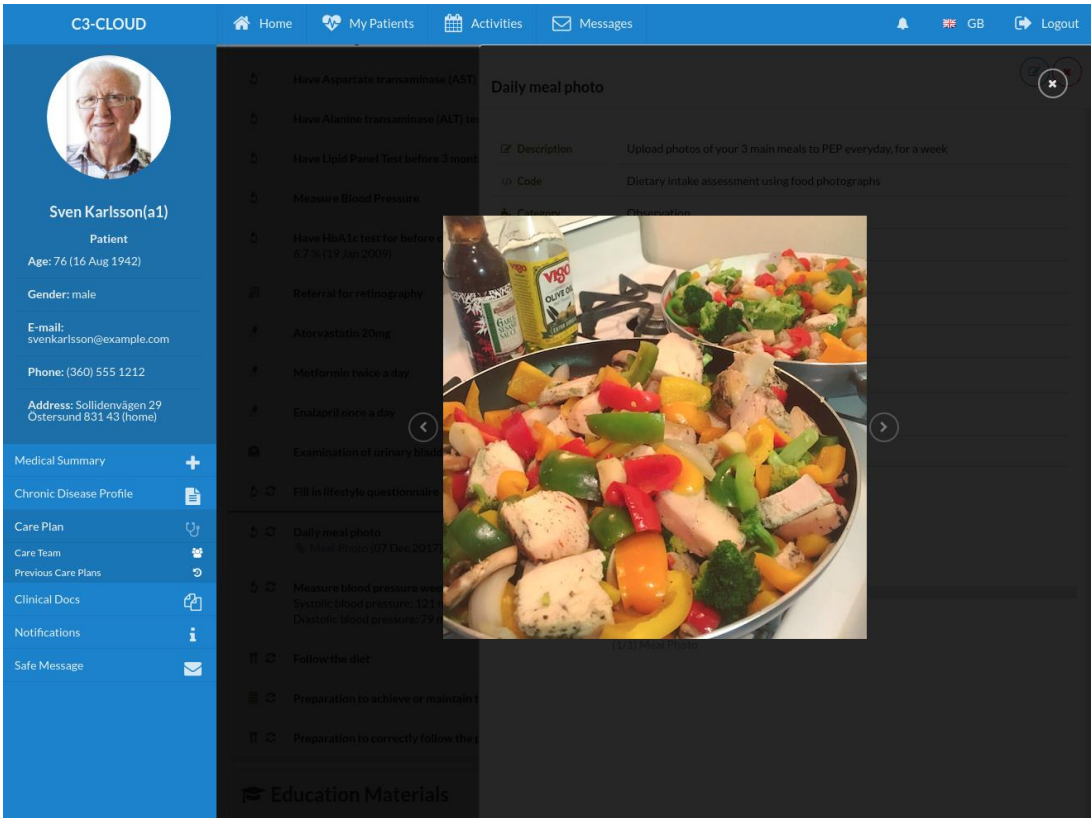


Figure 28 Activity with Photos

There are also some activities that asks patients to fill a questionnaire. When there is a filled questionnaire response for these activities, the user can see the answers from the activity details.

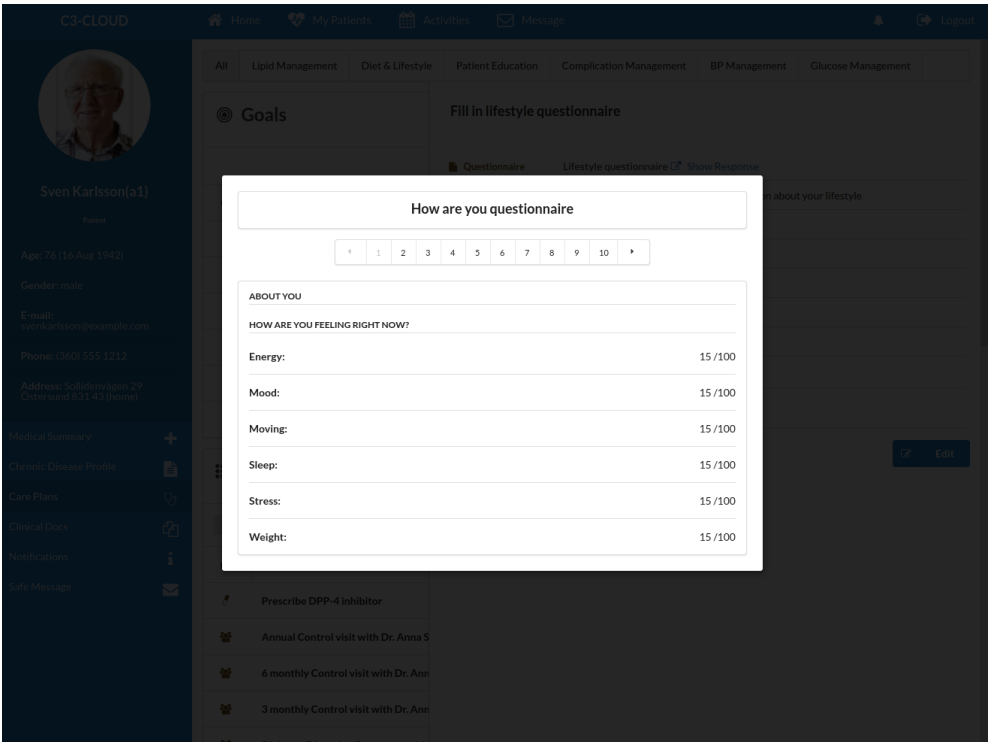


Figure 29 Questionnaire Response

6.1.5.6. Adding / updating an education material

The user can add education materials which are suggested by the CDS services or she can assign an education material from scratch by using “Add New Activity” button shown in Figure 20. While creating a new education material from scratch, user can either search for an existing material in the system (Figure 30) or create new one by giving the link of an online material or uploading a material (e.g., a PDF file) from her computer (Figure 31). Each pilot site in C3-Cloud has already identified tens of valid education materials and these are already imported in the system; hence creating a new URL from scratch will be rarely needed in operation.

The screenshot displays the C3-Cloud user interface. On the left, a sidebar shows the patient profile for Sven Karlsson, including his photo, name, age (76), gender (male), and contact information. Below this, a list of medical summary items is visible. The main content area is divided into several sections: 'Goals', 'Activities', 'Education Materials', and 'Suggestions'. The 'Education Materials' section lists existing materials like 'High blood pressure (hypertension)' and 'Type 2 diabetes'. On the right, a form titled 'Add New Activity' is open, allowing the user to create a new activity by selecting an existing material from the 'Search Material' dropdown or by clicking the 'Skip & Create New' button. The form includes fields for 'Title', 'Search Material', 'Outcome', and 'Progress'.

Figure 30 Creating a New Education Material with an Existing Material

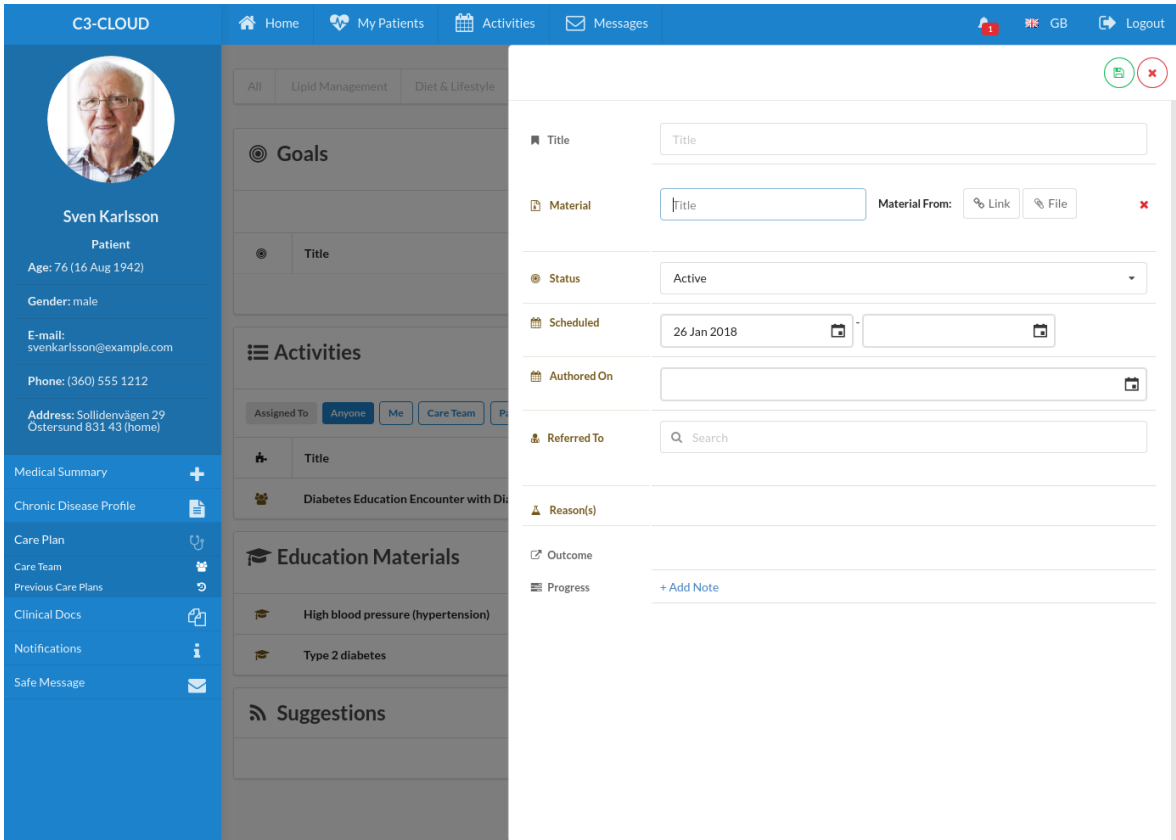


Figure 31 Creating a New Education Material by Uploading or Giving Link

6.1.5.7. Listing Previous Care Plans

If the patient has any inactive care plans, the user can list them by navigating to “Previous Care Plans” from the sidebar (Figure 32) and open them by clicking on any. In C3-Cloud, a patient can have only one active care plan at a time, as the project’s focus is on integrated care plans, not disease specific treatment plans.

The screenshot shows the C3-Cloud interface. The top navigation bar includes 'Home', 'My Patients', 'Activities', 'Message', and 'Logout'. The left sidebar shows the patient's profile for Sven Karlsson, including a photo, name, age (76), gender (male), email, phone, and address. Below the profile are links for Medical Summary, Chronic Disease Profile, Care Plan, Care Team, Previous Care Plans, Clinical Docs, Notifications, and Safe Message. The main content area is titled 'Care Plans of Sven Karlsson' and contains a table of active care plans.

Title	Start Date	Last Update	Next Review
Integrated care plan for hypertension, diabetes type II and renal failure	21 Jul 2009 11:00	12 Jan 2018 11:03	20 Oct 2009

Below the active care plans table is a section for 'Closed Care Plans' with a dropdown arrow.

Figure 32 Previous Care Plans

6.1.6. Care Team Management

6.1.6.1. Showing the Care Team

The user can see the assigned care team for a care plan from “Care Team” button below the “Care Plan” (Figure 33). Users can see information of each other or contact them (Figure 34) using this module.

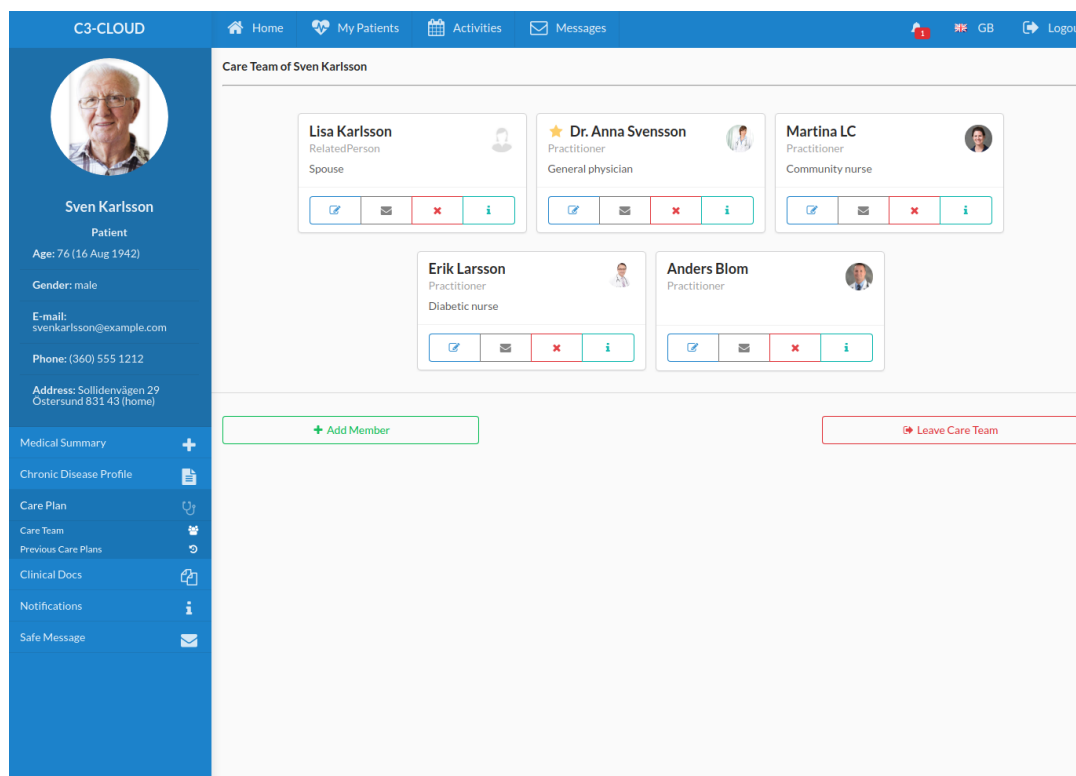


Figure 33 Care Team of Sven Karlsson

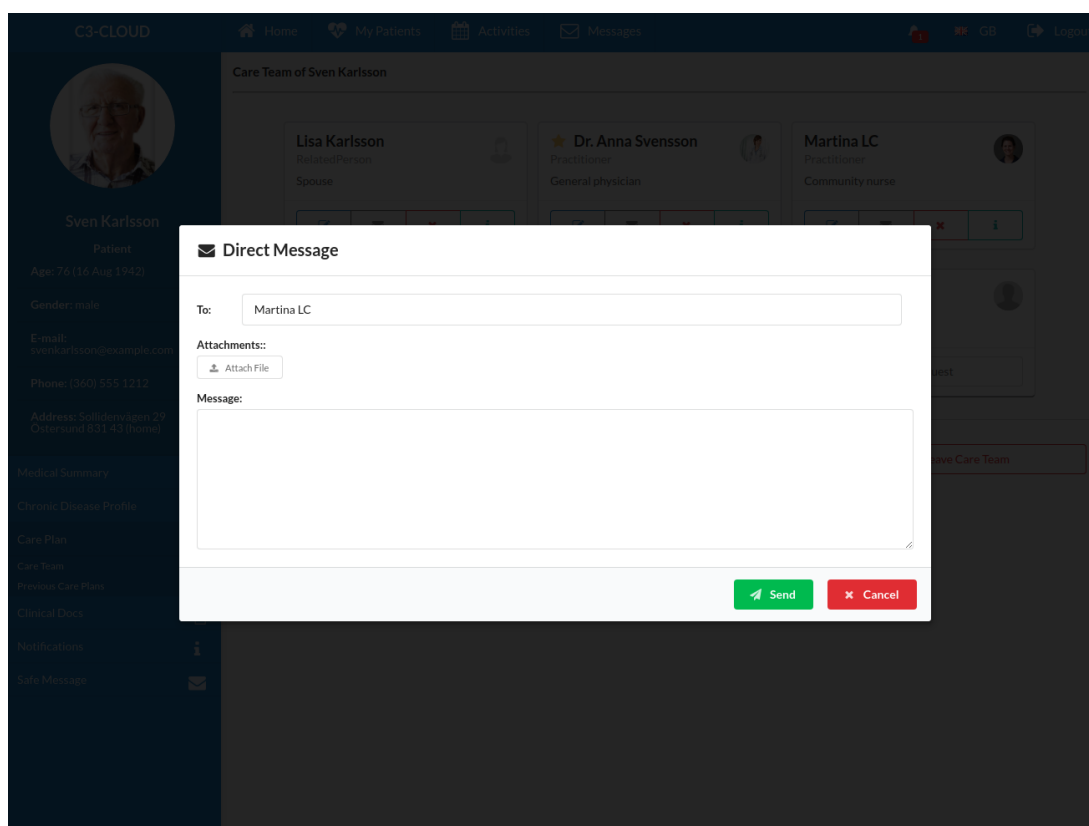


Figure 34 Sending Message to a Care Team Member

6.1.6.2. Updating Care Team Members

The Care Team Manager can add, remove or edit the members of a care team. A care team can have only one manager and all C3-Cloud pilot sites agree that this should be the GP of the patient. Non-manager members can only see the other members.

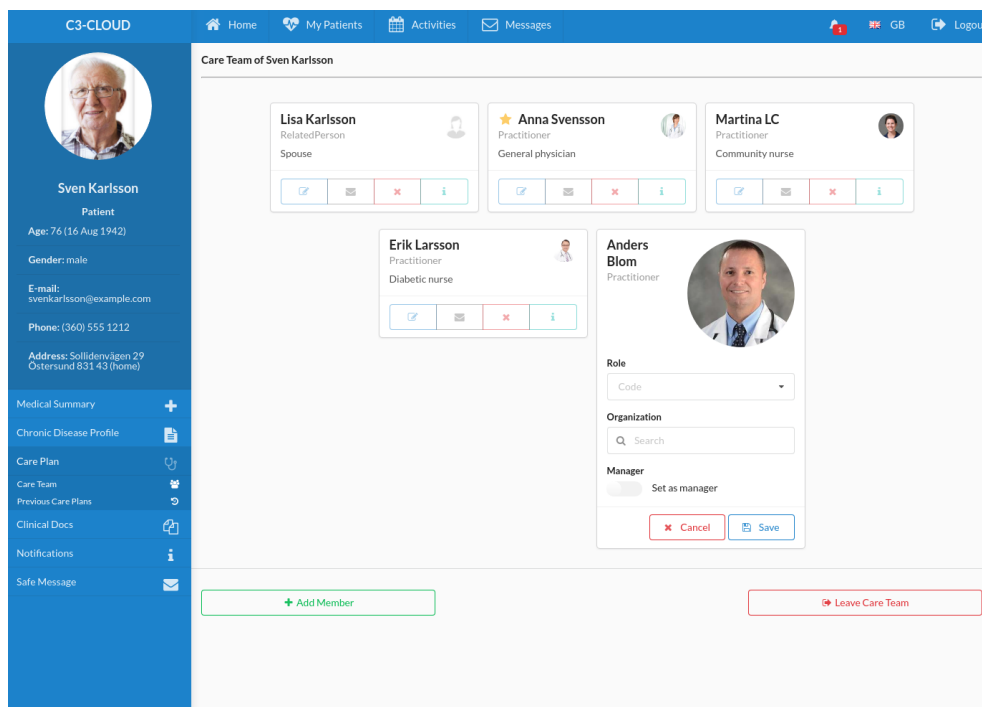


Figure 35 Editing a Member

To add a new member, after pressing “Add Member” button and selecting a user via search bar (Figure 36), a request message (Figure 38) is sent to the new member to approve participating in the care team. After the new member approves to participate, he will be added to the care team.

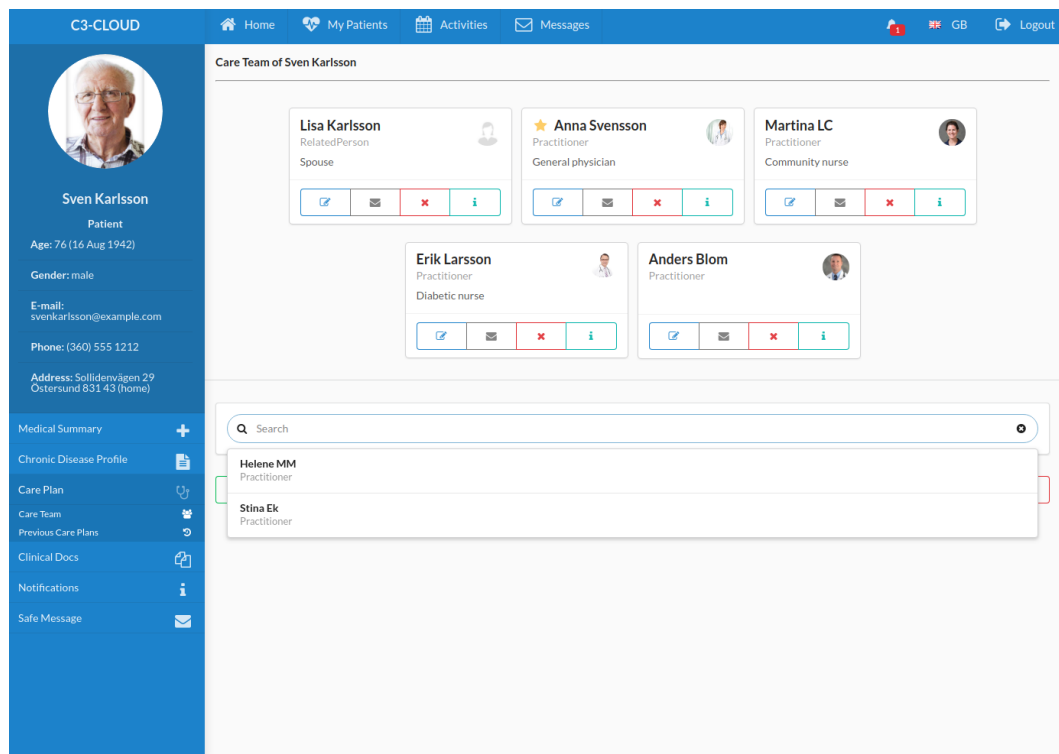


Figure 36 Selecting a User to Add to the Care Team

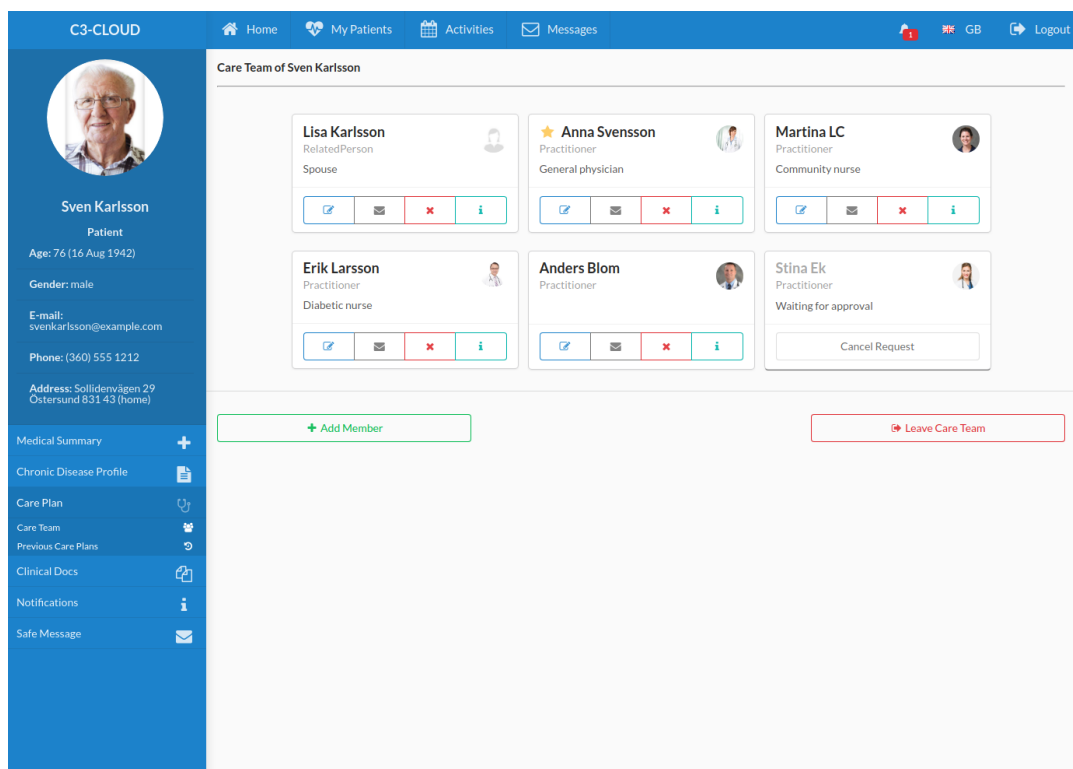


Figure 37 Waiting the New Member to Approve Participation

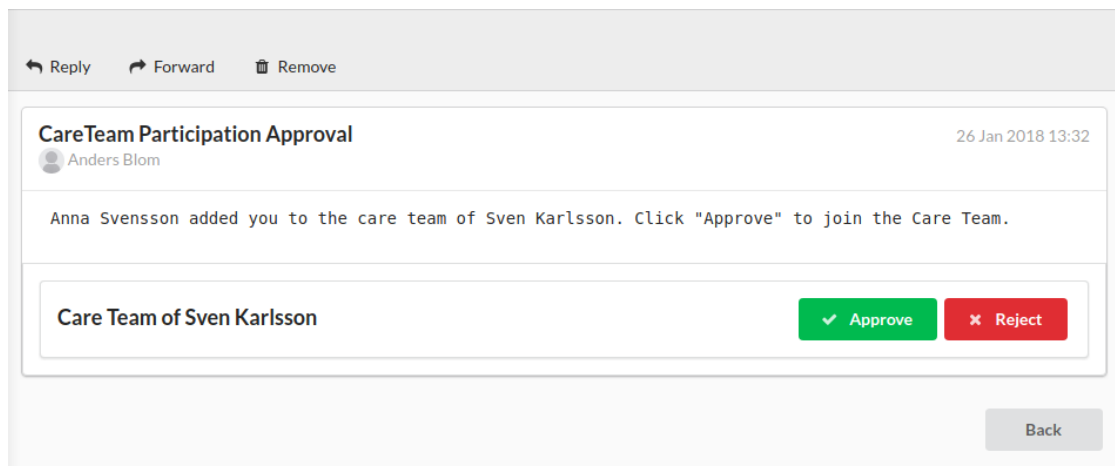


Figure 38 Approval Message for Participation

6.1.7. Activity Schedule

The user can see her scheduled activities like appointments, referral requests, etc. on a calendar in the “Activities” page (Figure 39). She can also edit these activities or add new ones using this module.

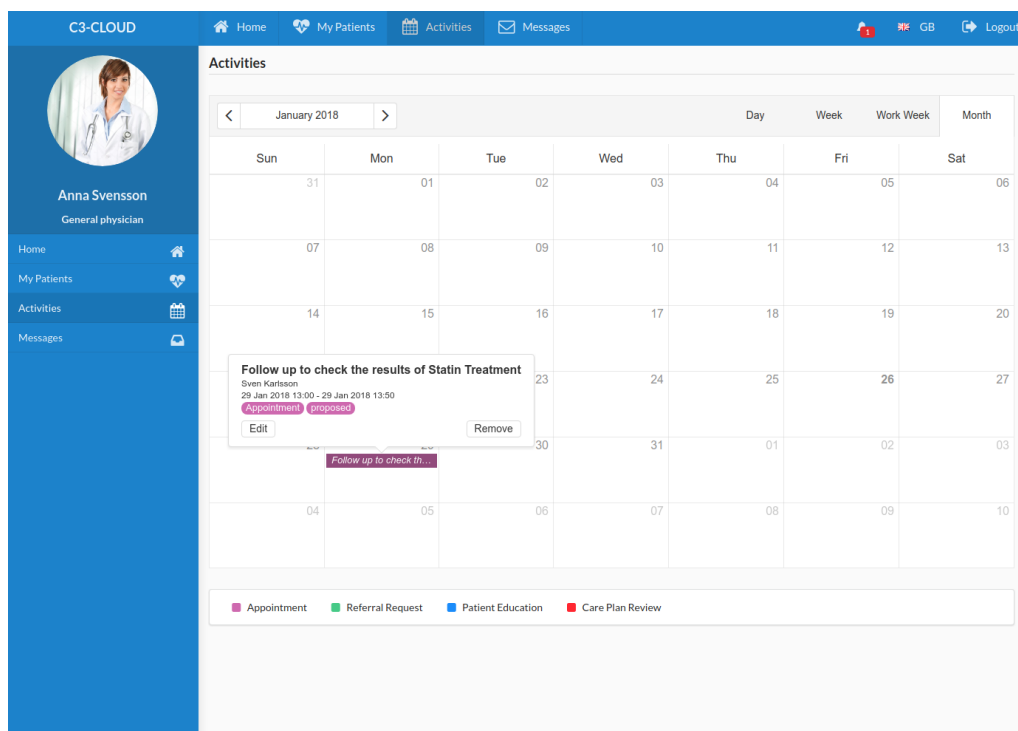


Figure 39 Scheduled Activities

6.1.8. Messaging

The user can communicate with other users or patients using the messaging module. She can send messages to patients, care team members or other practitioners to share information.

6.1.8.1. Inbox

The user can see the messages sent to her from Inbox section (Figure 40 - 1). The messages can be grouped by the participant of communication as care team members or patients (Figure 40 - 2). The user can also use “Filter Messages” (Figure 40 - 3) tool to search messages by a text that message body contains or search a user to see only messages related to him/her.

The screenshot displays the C3-Cloud inbox interface. On the left sidebar, the user profile for Anna Svensson, General physician, is shown. The main content area features a navigation bar with 'All', 'Patients', and 'Care Team Members' tabs. Below this is a table of messages. The table has columns for checkboxes, icons, titles, from, date, and patient. The messages listed are:

	h	Title	From	Date	Patient
<input type="checkbox"/>		Re: Fw: Cholesterol Results of Sven ...	Erik Larsson	31 Jan 2018 13:46	Sven Karlsson
<input type="checkbox"/>		Cholesterol Results of Sven Karlsson	Anders Blom	31 Jan 2018 13:34	Sven Karlsson
<input type="checkbox"/>		About our appointment	Sven Karlsson	31 Jan 2018 11:22	Sven Karlsson

At the top right, there is a 'Filter Messages' search bar. At the bottom, a pagination bar shows page 1.

Figure 40 Inbox

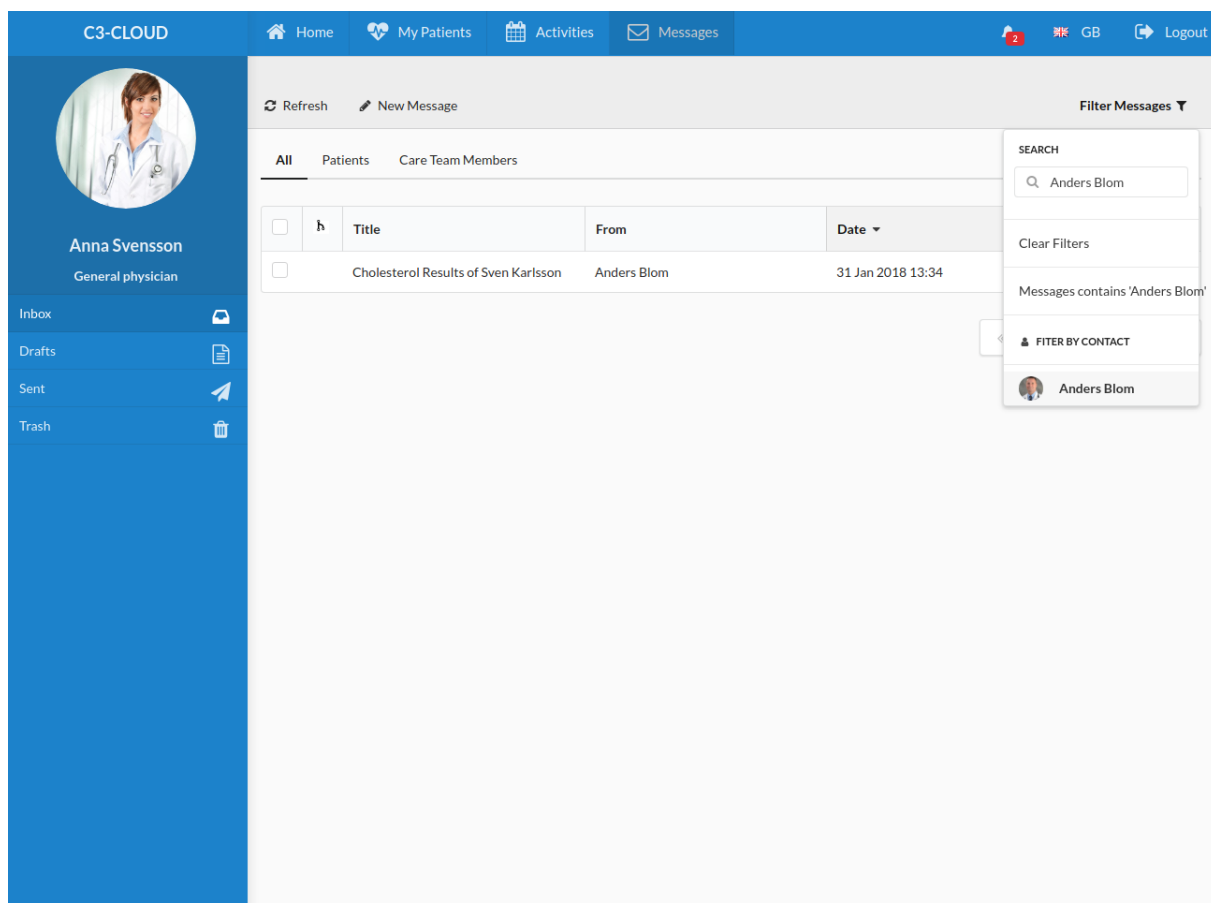


Figure 41 Filtering - Messages from a Care Team Member

6.1.8.2. Sending a Message

The user can send a message to one or more users or directly to the care team. The related patient of the message can be indicated to make tracking easier. Also, attachments are available in messages to share images, lab results or any other useful data between users.

The screenshot displays the 'C3-CLOUD' web application interface for sending a new message. The top navigation bar includes links for Home, My Patients, Activities, and Messages, along with user status indicators (2, HK, GB) and a Logout button. On the left, a sidebar identifies the user as Anna Svensson, a General physician, and lists email folders: Inbox, Drafts, Sent, and Trash. The main content area contains a form with fields for 'From' (pre-filled with Anna Svensson), 'To', 'Title', and 'Patient'. An 'Attach File' button is positioned above a large 'Message' text area. At the bottom right of the form are three buttons: 'Send' (green), 'Save' (blue), and 'Cancel' (red).

Figure 42 Sending New Message

There are also “Reply” and “Forward” features as common mail services. The user can see a conversation with replies as a thread (Figure 44).

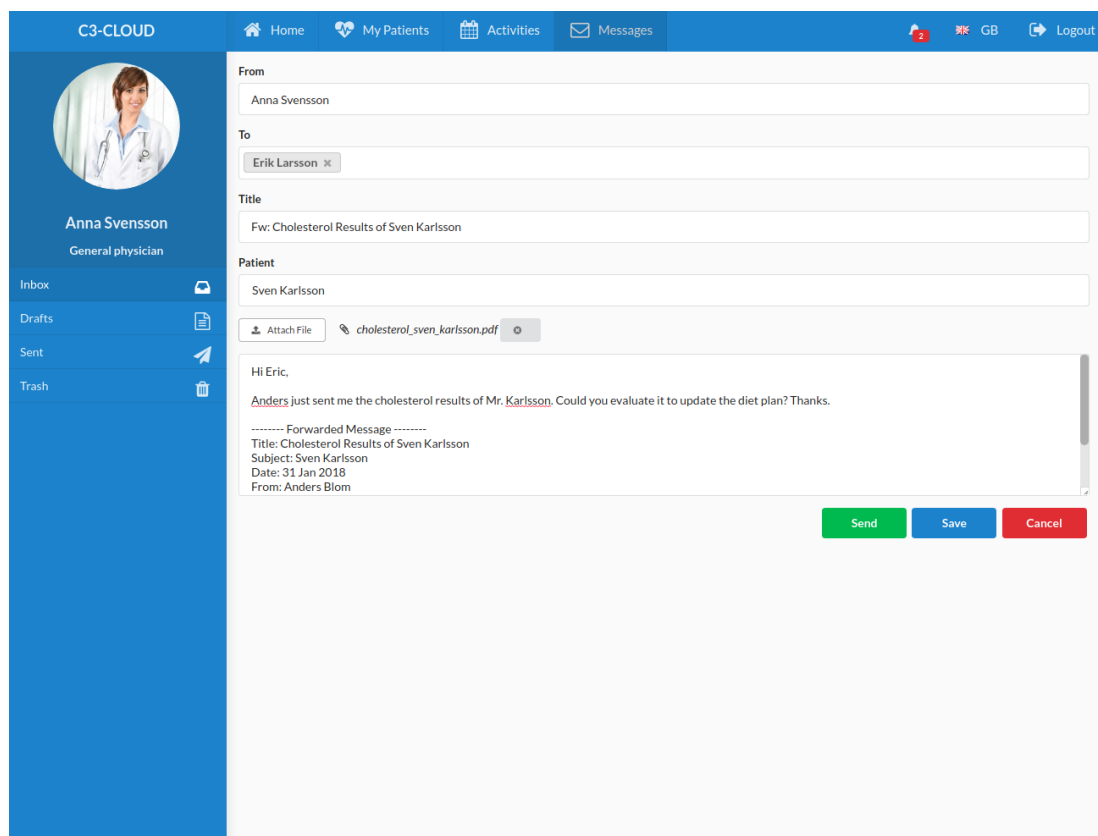


Figure 43 Forwarding a Message

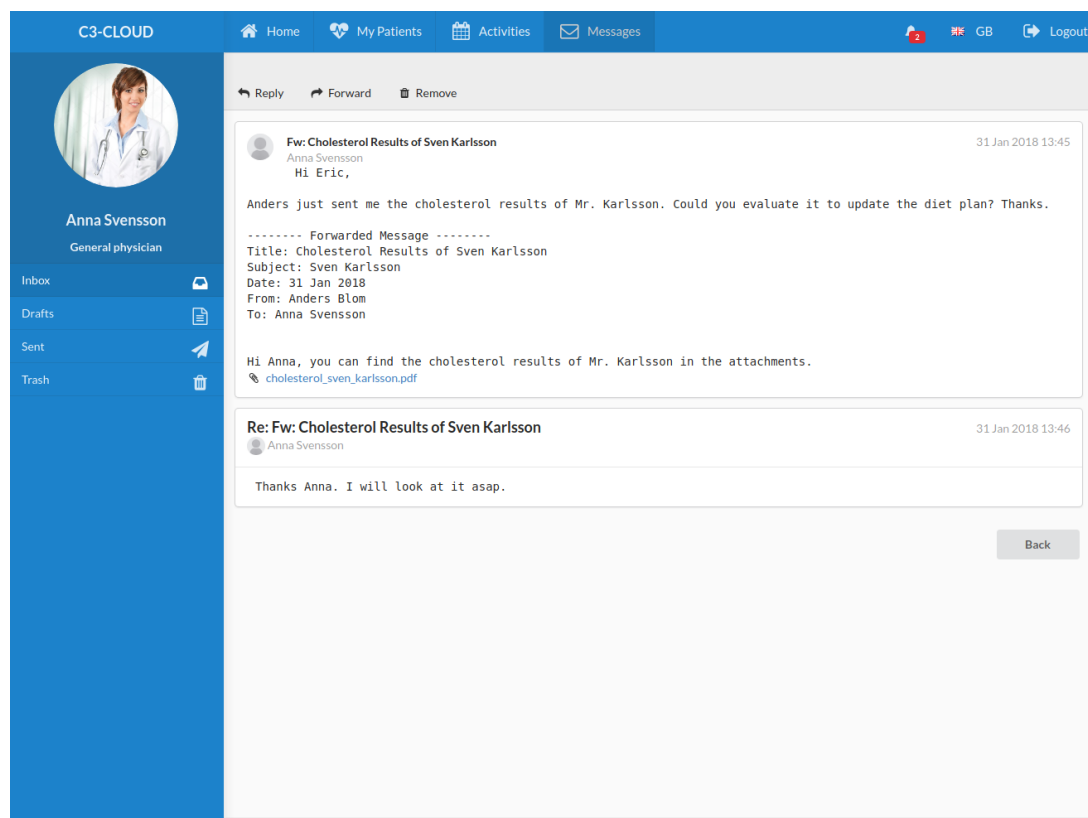


Figure 44 Conversation as Thread

6.1.8.3. Saving a Message

The user may want to write a message to send it in another time. Written messages can be saved as draft and edited any time. These messages can be found on “Drafts” section.

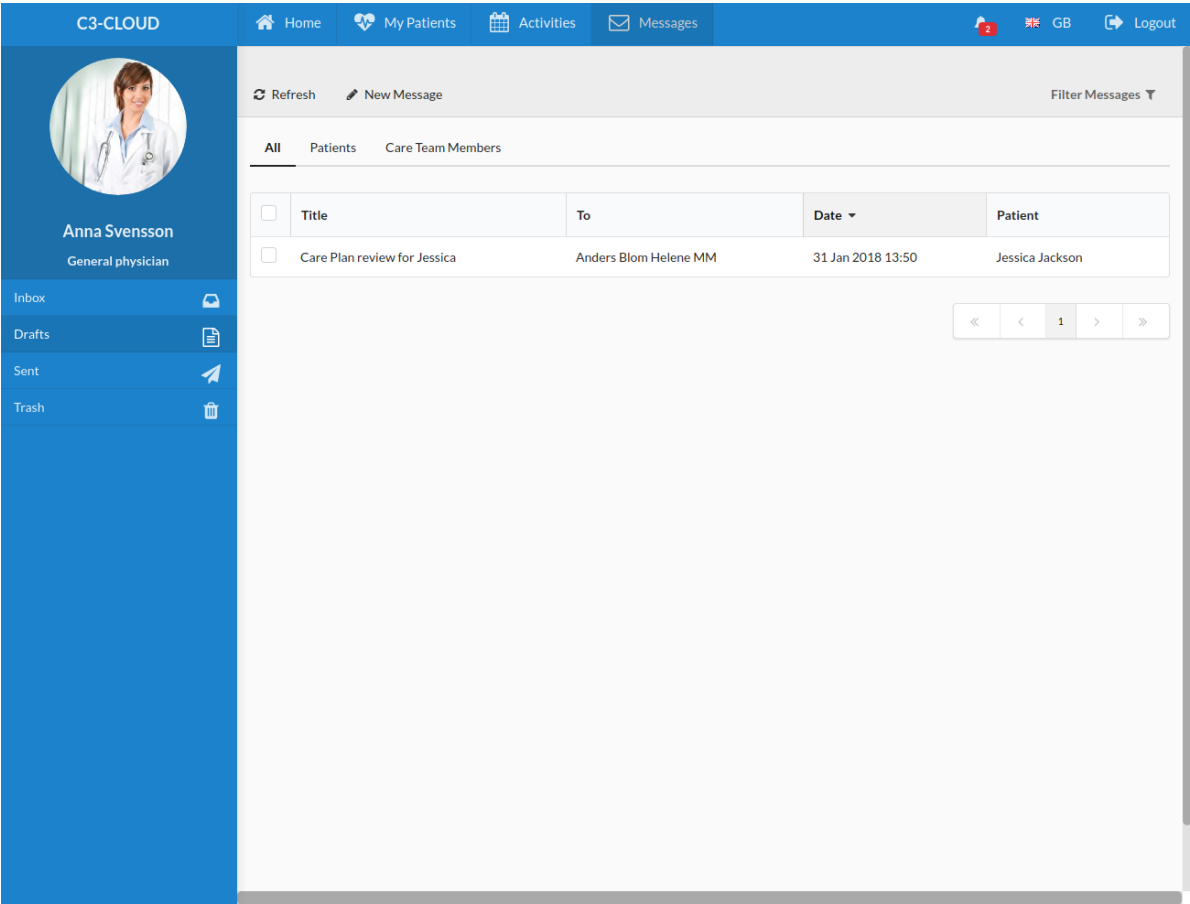


Figure 45 Drafts

C3-CLOUD

Home My Patients Activities Messages

2 GB Logout

Anna Svensson
General physician

Inbox Drafts Sent Trash

From: Anna Svensson

To: Anders Blom x Helene MM x

Title: Care Plan review for Jessica

Patient: Jessica Jackson

Attach File

Could we arrange an online meeting to review some goals in Jessica's care plan?

Send Save Cancel

Figure 46 Editing a Saved Message

6.1.8.4. Deleting a Message

Deleted messages are stored in the “Trash” section. These messages can be recovered and used later.

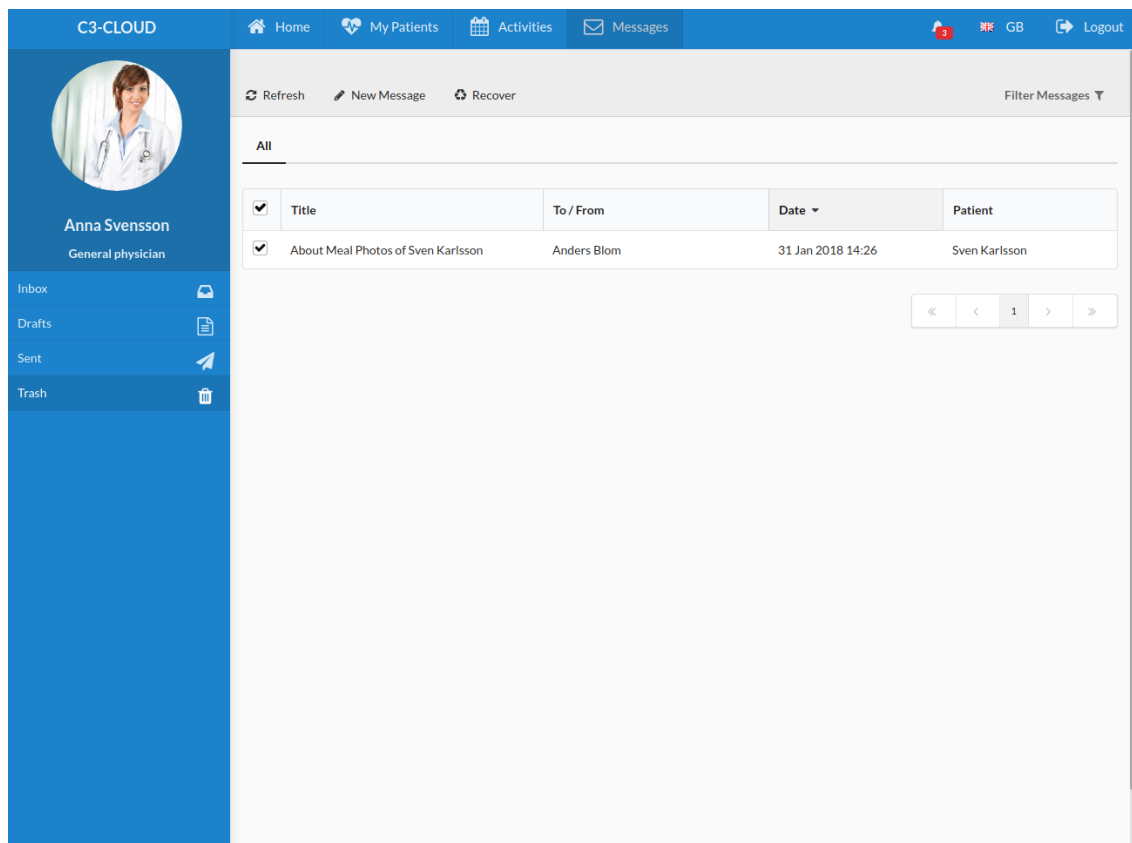


Figure 47 Trash

6.1.8.5. Notifications

The user can see the recent unread notifications via the default notification menu. However, if she wants to see all notifications including old ones, she can use “System Notifications” tab in the messaging module.

The screenshot displays the C3-Cloud web application interface. The top navigation bar includes links for Home, My Patients, Activities, and Messages, along with a user profile icon, a language selector (GB), and a Logout button. The left sidebar shows the user's profile (Anna Svensson, General physician) and email management options (Inbox, Drafts, Sent, Trash). The main content area is titled 'System Notifications' and features a table with two columns: 'Title' and 'Patient'. The table contains two entries, both with the title 'Care Plan Edited!' and the patient 'Sven Karlsson', sent from the 'SYSTEM' on January 26, 2018. A pagination control at the bottom right of the table shows the current page is 1 of 1.

	Title	From	Date	Patient
<input type="checkbox"/>	Care Plan Edited!	SYSTEM	26 Jan 2018 13:59	Sven Karlsson
<input type="checkbox"/>	Care Plan Edited!	SYSTEM	26 Jan 2018 13:58	Sven Karlsson

Figure 48 System Notifications

7. FUTURE PLANS

As explained and demonstrated in the earlier sections, all the functionalities of the Personalised Care Plan Development Platform (PCPDP) as a sub-component of the Coordinate Care and Cure Delivery Platform (C3DP) have been completed on time. The remaining work will focus on:

- further improvement of the system based on feedback from clinical experts thanks to the continuously happening usability studies and the component testing outcomes to take place within the scope of Task 9.2;
- finalization of integration with the other C3-Cloud components in Task 7.4 and testing the system with real (but un-identified) patient data;
- deployment of the system at the different sites and resolving any localization issue while doing so within the scope of Task 8.3.

8. REFERENCES

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9. APPENDIX I – A CAREPLAN RESOURCE EXAMPLE

```
{
  "resourceType": "Bundle",
  "id": "7ba3e747-2e95-49e7-8626-2461f312f5ac",
  "type": "searchset",
  "total": 1,
  "link": [
    {
      "relation": "self",
      "url": "http://app.srdc.com.tr/c3cloud/fhir/CarePlan?_id=a90df99d-6cc2-4200-b488-4ef87493d2e7&_include="
    }
  ],
  "entry": [
    {
      "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/CarePlan/a90df99d-6cc2-4200-b488-4ef87493d2e7",
      "resource": {
        "resourceType": "CarePlan",
        "meta": {
          "profile": [
            "http://www.c3-cloud.eu/fhir/StructureDefinition/C3C-CarePlan"
          ],
          "tag": [
            {
              "system": "http://www.c3-cloud.eu/fhir/ValueSet/data-origin",
              "code": "C3DP"
            }
          ],
          "versionId": "7",
          "lastUpdated": "2018-01-12T07:54:04Z"
        },
        "status": "active",
        "intent": "order",
        "category": [
          {
            "coding": [
              {
                "system": "urn:oid:2.16.840.1.113883.2.1.3.2.4.15",
                "code": "325671000000104",
                "display": "Integrated care plan"
              }
            ]
          }
        ],
        "subject": {
          "reference": "Patient/p-1-demo-a0",
          "display": "Sven Karlsson(a0)"
        },
        "goal": [
          {
            "reference": "Goal/6ee61d00-8cbc-4517-8712-33e7e7b7cd15",
            "display": "BP Management"
          },
          {
            "reference": "Goal/95fd16ad-ed24-4d14-87c7-698e17e62839",
            "display": "Complication Management"
          },
          {
            "reference": "Goal/ff61b658-401b-4e31-906b-13586012d608",
            "display": "Diet & Lifestyle"
          },
          {
            "reference": "Goal/e25f460d-2b6c-4994-b92b-2ad55f3121b0",
            "display": "Patient Education"
          },
          {
            "reference": "Goal/ea542c9c-de33-415b-8cac-d5b7e5d65c92",
            "display": "Glucose Management"
          },
          {
            "reference": "Goal/689ad6ee-d4af-4641-9a1e-0d7ac5649eae",
            "display": "Lipid Management"
          }
        ]
      }
    }
  ]
}
```

```

        "reference": "Goal/dfc801e7-55a9-4402-b094-aa8eb37ac985",
        "display": "Treatment target is supposed to be 46 mmol/mol (<= 6.4%)"
    },
    ],
    "title": "Integrated care plan",
    "careTeam": [
        {
            "reference": "CareTeam/45f5ef71-bbb8-4c0f-a699-8c2ee252e58c",
            "display": "Care Team of Sven Karlsson(a0)"
        }
    ],
    "period": {
        "start": "2017-12-08T12:21:21.853Z"
    },
    "author": [
        {
            "reference": "Practitioner/3c670b96-8657-4fe7-bc48-b4352a2b5284",
            "display": "Anna Svensson"
        }
    ],
    "id": "a90df99d-6cc2-4200-b488-4ef87493d2e7",
    "activity": [
        {
            "extension": [
                {
                    "url": "http://hl7.org/fhir/StructureDefinition/careplan-activity-title",
                    "valueString": "Medication Side-Effects"
                }
            ],
            "detail": {
                "status": "in-progress",
                "extension": [
                    {
                        "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/introducedBy",
                        "valueReference": {
                            "reference": "Practitioner/3c670b96-8657-4fe7-bc48-b4352a2b5284",
                            "display": "Anna Svensson"
                        }
                    },
                    {
                        "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/identifier",
                        "valueIdentifier": {
                            "value": "e91c662c-97c6-b923-7c1a-fb70f8eb1e98"
                        }
                    }
                ]
            },
            "category": {
                "coding": [
                    {
                        "system": "http://hl7.org/fhir/care-plan-activity-category",
                        "code": "observation",
                        "display": "Observation"
                    }
                ]
            },
            "definition": {
                "reference": "Questionnaire/55t70dpz17f1cu7oe0xz5wmghadsrk3p",
                "display": "Medication Side-Effects"
            },
            "code": {
                "coding": [
                    {
                        "system": "http://snomed.info/sct",
                        "code": "445536008",
                        "display": "Assessment using assessment scale"
                    }
                ]
            },
            "goal": [
                {
                    "reference": "Goal/ea542c9c-de33-415b-8cac-d5b7e5d65c92",
                    "display": "Glucose Management"
                }
            ],
            "scheduledPeriod": {
                "start": "2017-12-29T12:20:00.000Z",
                "end": "2018-01-05T12:20:00.000Z"
            }
        }
    ]

```

```

    }
  },
  {
    "extension": [
      {
        "url": "http://hl7.org/fhir/StructureDefinition/careplan-activity-title",
        "valueString": "Type 2 Diabetes Education Material for patients"
      }
    ],
    "reference": {
      "reference": "CommunicationRequest/f71e07ba-6edb-4b49-b473-5c91d00dedce",
      "display": "Recommend Type 2 Diabetes Education"
    }
  },
  {
    "extension": [
      {
        "url": "http://hl7.org/fhir/StructureDefinition/careplan-activity-title",
        "valueString": "Daily meal photo"
      }
    ],
    "detail": {
      "status": "in-progress",
      "extension": [
        {
          "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/introducedBy",
          "valueReference": {
            "reference": "Practitioner/3c670b96-8657-4fe7-bc48-b4352a2b5284",
            "display": "Anna Svensson"
          }
        }
      ],
      {
        "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/identifier",
        "valueIdentifier": {
          "value": "11aca212-ebaa-5373-9135-1c07293a22b6"
        }
      }
    ],
    "code": {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "226075008",
          "display": "Dietary intake assessment using food photographs"
        }
      ]
    },
    "goal": [
      {
        "reference": "Goal/ff61b658-401b-4e31-906b-13586012d608",
        "display": "Diet & Lifestyle"
      }
    ],
    "scheduledTiming": {
      "repeat": {
        "frequency": 3,
        "period": 1,
        "periodUnit": "d"
      }
    }
  },
  {
    "extension": [
      {
        "url": "http://hl7.org/fhir/StructureDefinition/careplan-activity-title",
        "valueString": "Prescribe metformin 500mg twice a day"
      }
    ],
    "reference": {
      "reference": "MedicationRequest/61cbe9a9-59f5-447d-a420-06b2a98119f2",
      "display": "Metformin 500mg twice a day"
    }
  },
  {
    "extension": [

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        {
            "url": "http://hl7.org/fhir/StructureDefinition/careplan-activity-title",
            "valueString": "Offer Starting Statin Treatment"
        }
    ],
    "reference": {
        "reference": "MedicationRequest/67fda2db-c454-4bd3-aa89-fcca4f3e071c",
        "display": "20mg daily"
    }
}
],
},
"search": {
    "mode": "match"
}
},
{
    "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/Patient/p-1-demo-a0",
    "resource": {
        "resourceType": "Patient",
        "id": "p-1-demo-a0",
        "meta": {
            "profile": [
                "http://hl7.org/fhir/us/core/StructureDefinition/us-core-patient"
            ],
            "versionId": "7",
            "lastUpdated": "2018-01-30T11:43:54Z"
        },
        "identifier": [
            {
                "value": "19420816-1010",
                "system": "http://www.example.com/identifiers/patient"
            }
        ],
        "active": true,
        "name": [
            {
                "family": "Karlsson(a0)",
                "given": [
                    "Sven"
                ]
            }
        ],
        "telecom": [
            {
                "system": "phone",
                "value": "(360) 555 1212",
                "use": "mobile"
            },
            {
                "system": "email",
                "value": "svenkarlsson@example.com",
                "use": "home"
            }
        ],
        "gender": "male",
        "birthDate": "1942-08-16",
        "address": [
            {
                "use": "home",
                "line": [
                    "Sollidenvägen 29"
                ],
                "city": "Östersund",
                "postalCode": "831 43"
            }
        ],
        "maritalStatus": {
            "coding": [
                {
                    "system": "http://hl7.org/fhir/v3/MaritalStatus",
                    "code": "M",
                    "display": "Married"
                }
            ]
        }
    }
},

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    "search": {
      "mode": "include"
    },
  },
  {
    "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/CommunicationRequest/f71e07ba-6edb-4b49-b473-5c91d00dedce",
    "resource": {
      "resourceType": "CommunicationRequest",
      "status": "active",
      "category": [
        {
          "coding": [
            {
              "system": "http://hl7.org/fhir/communication-category",
              "code": "instruction",
              "display": "Instruction"
            }
          ]
        }
      ],
      "payload": [
        {
          "contentAttachment": {
            "contentType": "text/html",
            "language": "en",
            "url": "https://patient.info/health/type-2-diabetes",
            "title": "Recommend Type 2 Diabetes Education"
          }
        }
      ],
      "occurrencePeriod": {
        "start": "2017-07-22T00:00:00.000Z"
      },
      "authoredOn": "2017-07-21T08:22:00.000Z",
      "extension": [
        {
          "url": "http://hl7.org/fhir/StructureDefinition/goal-pertainsToGoal",
          "valueReference": {
            "reference": "Goal/e25f460d-2b6c-4994-b92b-2ad55f3121b0",
            "display": "Patient Education"
          }
        }
      ],
      "subject": {
        "reference": "Patient/p-1-demo-a0",
        "display": "Sven Karlsson(a0)"
      },
      "id": "f71e07ba-6edb-4b49-b473-5c91d00dedce",
      "meta": {
        "versionId": "1",
        "lastUpdated": "2017-12-08T12:30:18Z"
      }
    },
    "search": {
      "mode": "include"
    }
  },
  {
    "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/MedicationRequest/61cbe9a9-59f5-447d-a420-06b2a98119f2",
    "resource": {
      "resourceType": "MedicationRequest",
      "status": "draft",
      "intent": "proposal",
      "subject": {
        "reference": "Patient/p-1-demo-a0",
        "display": "Sven Karlsson(a0)"
      },
      "medicationCodeableConcept": {
        "coding": [
          {
            "system": "http://www.whooc.no/atc",
            "code": "A10BA02",
            "display": "Metformin"
          }
        ]
      }
    }
  }
]

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    },
    "authoredOn": "2017-12-08T12:27:13.766Z",
    "dosageInstruction": [
      {
        "text": "Metformin 500mg twice a day",
        "timing": {
          "repeat": {
            "boundsPeriod": {
              "start": "2017-12-08T12:27:13.766Z"
            },
            "frequency": 2,
            "period": 1,
            "periodUnit": "d",
            "when": [
              "CM"
            ]
          }
        },
        "route": {
          "coding": [
            {
              "system": "http://snomed.info/sct",
              "code": "26643006",
              "display": "Oral route"
            }
          ]
        },
        "doseQuantity": {
          "value": 500,
          "unit": "milligram",
          "system": "http://unitsofmeasure.org",
          "code": "mg"
        }
      }
    ],
    "extension": [
      {
        "url": "http://hl7.org/fhir/StructureDefinition/goal-pertainsToGoal",
        "valueReference": {
          "reference": "Goal/ea542c9c-de33-415b-8cac-d5b7e5d65c92",
          "display": "Glucose Management"
        }
      }
    ],
    "requester": {
      "agent": {
        "reference": "Practitioner/3c670b96-8657-4fe7-bc48-b4352a2b5284",
        "display": "Anna Svensson"
      }
    },
    "id": "61cbe9a9-59f5-447d-a420-06b2a98119f2",
    "meta": {
      "versionId": "1",
      "lastUpdated": "2017-12-08T12:29:00Z"
    },
    "search": {
      "mode": "include"
    },
    {
      "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/MedicationRequest/67fda2db-c454-4bd3-aa89-fcca4f3e071c",
      "resource": {
        "resourceType": "MedicationRequest",
        "status": "draft",
        "intent": "proposal",
        "subject": {
          "reference": "Patient/p-1-demo-a0",
          "display": "Sven Karlsson(a0)"
        },
        "medicationCodeableConcept": {
          "coding": [
            {
              "system": "http://www.whocc.no/atc",
              "code": "C10AA05",
              "display": "atorvastatin"
            }
          ]
        }
      }
    }
  ]
}

```



```

    }
  ]
},
"authoredOn": "2018-01-12T07:52:57.583Z",
"dosageInstruction": [
  {
    "text": "20mg daily",
    "doseQuantity": {
      "value": 20,
      "unit": "mg",
      "system": "http://unitsofmeasure.org",
      "code": "mg"
    }
  }
],
"extension": [
  {
    "url": "http://hl7.org/fhir/StructureDefinition/goal-pertainsToGoal",
    "valueReference": {
      "reference": "Goal/689ad6ee-d4af-4641-9a1e-0d7ac5649eae",
      "display": "Lipid Management"
    }
  }
],
"requester": {
  "agent": {
    "reference": "Practitioner/3c670b96-8657-4fe7-bc48-b4352a2b5284",
    "display": "Anna Svensson"
  }
},
"id": "67fda2db-c454-4bd3-aa89-fcca4f3e071c",
"meta": {
  "versionId": "1",
  "lastUpdated": "2018-01-12T07:54:04Z"
},
"search": {
  "mode": "include"
},
},
{
  "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/CareTeam/45f5ef71-bbb8-4c0f-a699-8c2ee252e58c",
  "resource": {
    "resourceType": "CareTeam",
    "status": "active",
    "name": "Care Team of Sven Karlsson(a0)",
    "subject": {
      "reference": "Patient/p-1-demo-a0",
      "display": "Sven Karlsson(a0)"
    },
    "participant": [
      {
        "extension": [
          {
            "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/isManager",
            "valueBoolean": true
          }
        ],
        "member": {
          "reference": "Practitioner/3c670b96-8657-4fe7-bc48-b4352a2b5284",
          "display": "Anna Svensson"
        },
        "period": {
          "start": "2017-12-08T12:19:45.086Z"
        }
      },
      {
        "role": {
          "coding": [
            {
              "system": "http://snomed.info/sct",
              "code": "224543004",
              "display": "Diabetic nurse"
            }
          ]
        }
      }
    ]
  },
},

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      "member": {
        "reference": "Practitioner/fb1bdc33-6593-48bf-92ed-e3508e0ad809",
        "display": "Erik Larsson"
      },
      "period": {
        "start": "2017-12-08T12:21:03.665Z"
      }
    },
    {
      "member": {
        "reference": "RelatedPerson/rp-1-demo-a0",
        "display": "Lisa Karlsson"
      },
      "period": {
        "start": "2017-12-08T12:21:18.794Z"
      }
    },
    {
      "member": {
        "reference": "Practitioner/0193a28e-4b12-4b8b-8f49-1d51161e361a",
        "display": "Anders Blom"
      }
    }
  ],
  "id": "45f5ef71-bbb8-4c0f-a699-8c2ee252e58c",
  "meta": {
    "versionId": "3",
    "lastUpdated": "2018-02-06T12:29:15Z"
  }
},
"search": {
  "mode": "include"
}
},
{
  "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/Goal/689ad6ee-d4af-4641-9a1e-0d7ac5649eae",
  "resource": {
    "resourceType": "Goal",
    "category": [
      {
        "coding": [
          {
            "system": "http://www.c3-cloud.eu/fhir/ValueSet/goal-category",
            "code": "high-level"
          }
        ]
      }
    ]
  },
  "extension": [
    {
      "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/title",
      "valueString": "Lipid Management"
    },
    {
      "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
      "extension": [
        {
          "url": "id",
          "valueString": "REM_LIPID_LOWERING"
        },
        {
          "url": "prefetch"
        }
      ]
    }
  ],
  "description": {
    "coding": [
      {
        "system": "http://snomed.info/sct",
        "code": "315598000",
        "display": "Lipid disorder monitoring"
      }
    ],
    "text": "High-level goal for lipid management"
  },

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    "status": "in-progress",
    "meta": {
      "tag": [
        {
          "system": "http://www.c3-cloud.eu/fhir/ValueSet/data-origin",
          "code": "C3DP"
        }
      ],
      "versionId": "1",
      "lastUpdated": "2017-12-08T12:25:03Z"
    },
    "subject": {
      "reference": "Patient/p-1-demo-a0",
      "display": "Sven Karlsson(a0)"
    },
    "startDate": "2017-12-08",
    "id": "689ad6ee-d4af-4641-9a1e-0d7ac5649eae"
  },
  "search": {
    "mode": "include"
  }
},
{
  "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/Goal/6ee61d00-8cbc-4517-8712-33e7e7b7cd15",
  "resource": {
    "resourceType": "Goal",
    "category": [
      {
        "coding": [
          {
            "system": "http://www.c3-cloud.eu/fhir/ValueSet/goal-category",
            "code": "high-level"
          }
        ]
      }
    ],
    "extension": [
      {
        "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/title",
        "valueString": "BP Management"
      },
      {
        "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
        "extension": [
          {
            "url": "id",
            "valueString": "REM_BP_MANAGEMENT"
          },
          {
            "url": "prefetch"
          }
        ]
      }
    ],
    "description": {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "385846000",
          "display": "Manage blood pressure"
        }
      ],
      "text": "High-level goal for blood pressure management"
    },
    "status": "in-progress",
    "meta": {
      "tag": [
        {
          "system": "http://www.c3-cloud.eu/fhir/ValueSet/data-origin",
          "code": "C3DP"
        }
      ],
      "versionId": "1",
      "lastUpdated": "2017-12-08T12:25:03Z"
    },
    "subject": {

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        "reference": "Patient/p-1-demo-a0",
        "display": "Sven Karlsson(a0)"
    },
    "startDate": "2017-12-08",
    "id": "6ee61d00-8cbc-4517-8712-33e7e7b7cd15"
},
"search": {
    "mode": "include"
}
},
{
    "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/Goal/95fd16ad-ed24-4d14-87c7-698e17e62839",
    "resource": {
        "resourceType": "Goal",
        "category": [
            {
                "coding": [
                    {
                        "system": "http://www.c3-cloud.eu/fhir/ValueSet/goal-category",
                        "code": "high-level"
                    }
                ]
            }
        ],
        "extension": [
            {
                "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/title",
                "valueString": "Complication Management"
            },
            {
                "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
                "extension": [
                    {
                        "url": "id",
                        "valueString": "LOC_DIABETES_COMPLICATIONS"
                    },
                    {
                        "url": "prefetch"
                    }
                ]
            },
            {
                "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
                "extension": [
                    {
                        "url": "id",
                        "valueString": "REM_DIABETIC_FOOT"
                    },
                    {
                        "url": "prefetch"
                    }
                ]
            },
            {
                "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
                "extension": [
                    {
                        "url": "id",
                        "valueString": "LOC_EYE_DISEASE"
                    },
                    {
                        "url": "prefetch"
                    }
                ]
            }
        ],
        "description": {
            "text": "High-level goal for complication management"
        },
        "status": "in-progress",
        "meta": {
            "tag": [
                {
                    "system": "http://www.c3-cloud.eu/fhir/ValueSet/data-origin",
                    "code": "C3DP"
                }
            ]
        }
    }
}

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```

    ],
    "versionId": "1",
    "lastUpdated": "2017-12-08T12:25:03Z"
  },
  "subject": {
    "reference": "Patient/p-1-demo-a0",
    "display": "Sven Karlsson(a0)"
  },
  "startDate": "2017-12-08",
  "id": "95fd16ad-ed24-4d14-87c7-698e17e62839"
},
"search": {
  "mode": "include"
}
},
{
  "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/Goal/dfc801e7-55a9-4402-b094-aa8eb37ac985",
  "resource": {
    "resourceType": "Goal",
    "status": "proposed",
    "category": [
      {
        "coding": [
          {
            "system": "http://hl7.org/fhir/goal-category",
            "code": "safety"
          }
        ]
      }
    ],
    "description": {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "51798006",
          "display": "Decreased glucose level (finding)"
        }
      ],
      "text": "Keep HbA1c level below 46 mmol/mol (<= 6.4%)"
    },
    "startDate": "2017-12-08",
    "target": {
      "measure": {
        "coding": [
          {
            "system": "http://loinc.org",
            "code": "4548-4",
            "display": "Hemoglobin A1c/Hemoglobin.total in Blood"
          }
        ]
      }
    },
    "detailRange": {
      "high": {
        "value": 46,
        "unit": "mmol/mol",
        "system": "http://unitsofmeasure.org/",
        "code": "mmol/mol"
      }
    }
  },
  "extension": [
    {
      "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/title",
      "valueString": "Treatment target is supposed to be 46 mmol/mol (<= 6.4%)"
    },
    {
      "extension": [
        {
          "url": "type",
          "valueCodeableConcept": {
            "coding": [
              {
                "system": "app-internal",
                "code": "parent"
              }
            ]
          }
        }
      ]
    }
  ]
}

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        }
      },
      {
        "url": "target",
        "valueReference": {
          "reference": "Goal/ea542c9c-de33-415b-8cac-d5b7e5d65c92"
        }
      }
    ],
    "url": "http://hl7.org/fhir/StructureDefinition/goal-relationship"
  },
  ],
  "subject": {
    "reference": "Patient/p-1-demo-a0",
    "display": "Sven Karlsson(a0)"
  },
  "expressedBy": {
    "reference": "Practitioner/3c670b96-8657-4fe7-bc48-b4352a2b5284",
    "display": "Anna Svensson"
  },
  "id": "dfc801e7-55a9-4402-b094-aa8eb37ac985",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2017-12-08T12:28:36Z"
  }
},
"search": {
  "mode": "include"
}
},
{
  "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/Goal/e25f460d-2b6c-4994-b92b-2ad55f3121b0",
  "resource": {
    "resourceType": "Goal",
    "category": [
      {
        "coding": [
          {
            "system": "http://www.c3-cloud.eu/fhir/ValueSet/goal-category",
            "code": "high-level"
          }
        ]
      }
    ],
    "extension": [
      {
        "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/title",
        "valueString": "Patient Education"
      },
      {
        "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
        "extension": [
          {
            "url": "id",
            "valueString": "LOC_PAT_EDUCATION"
          },
          {
            "url": "prefetch"
          }
        ]
      }
    ],
    "description": {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "311401005",
          "display": "Patient education"
        }
      ],
      "text": "High-level goal for patient education"
    },
    "status": "in-progress",
    "meta": {
      "tag": [
        {

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        "system": "http://www.c3-cloud.eu/fhir/ValueSet/data-origin",
        "code": "C3DP"
    }
},
"versionId": "1",
"lastUpdated": "2017-12-08T12:25:03Z"
},
"subject": {
    "reference": "Patient/p-1-demo-a0",
    "display": "Sven Karlsson(a0)"
},
"startDate": "2017-12-08",
"id": "e25f460d-2b6c-4994-b92b-2ad55f3121b0"
},
"search": {
    "mode": "include"
}
},
{
    "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/Goal/ea542c9c-de33-415b-8cac-d5b7e5d65c92",
    "resource": {
        "resourceType": "Goal",
        "category": [
            {
                "coding": [
                    {
                        "system": "http://www.c3-cloud.eu/fhir/ValueSet/goal-category",
                        "code": "high-level"
                    }
                ]
            }
        ]
    },
    "extension": [
        {
            "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/title",
            "valueString": "Glucose Management"
        },
        {
            "extension": [
                {
                    "url": "type",
                    "valueCodeableConcept": {
                        "coding": [
                            {
                                "system": "http://hl7.org/fhir/goal-relationship-type",
                                "code": "milestone"
                            }
                        ]
                    }
                }
            ]
        },
        {
            "url": "target",
            "valueReference": {
                "reference": "Goal/dfc801e7-55a9-4402-b094-aa8eb37ac985",
                "display": "Treatment target is supposed to be 46 mmol/mol (<= 6.4%)"
            }
        }
    ],
    "url": "http://hl7.org/fhir/StructureDefinition/goal-relationship"
},
{
    "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
    "extension": [
        {
            "url": "id",
            "valueString": "REM_HBA1C_TARGET"
        },
        {
            "url": "prefetch"
        }
    ]
},
{
    "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
    "extension": [

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        "url": "id",
        "valueString": "REM_GLUCOSE_MEDICATION"
      },
      {
        "url": "prefetch"
      }
    ]
  },
  {
    "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
    "extension": [
      {
        "url": "id",
        "valueString": "LOC_GLUCOSE_SELF_MONITORING"
      },
      {
        "url": "prefetch"
      }
    ]
  }
],
"description": {
  "coding": [
    {
      "system": "http://snomed.info/sct",
      "code": "418389000",
      "display": "Blood glucose management"
    }
  ],
  "text": "High-level goal for blood glucose management"
},
"status": "in-progress",
"meta": {
  "tag": [
    {
      "system": "http://www.c3-cloud.eu/fhir/ValueSet/data-origin",
      "code": "C3DP"
    }
  ],
  "versionId": "2",
  "lastUpdated": "2017-12-08T12:28:36Z"
},
"subject": {
  "reference": "Patient/p-1-demo-a0",
  "display": "Sven Karlsson(a0)"
},
"startDate": "2017-12-08",
"id": "ea542c9c-de33-415b-8cac-d5b7e5d65c92"
},
"search": {
  "mode": "include"
}
},
{
  "fullUrl": "http://app.srdc.com.tr/c3cloud/fhir/Goal/ff61b658-401b-4e31-906b-13586012d608",
  "resource": {
    "resourceType": "Goal",
    "category": [
      {
        "coding": [
          {
            "system": "http://www.c3-cloud.eu/fhir/ValueSet/goal-category",
            "code": "high-level"
          }
        ]
      }
    ]
  },
  "extension": [
    {
      "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/title",
      "valueString": "Diet & Lifestyle"
    },
    {
      "url": "http://www.c3-cloud.eu/fhir/StructureDefinition/cdsService",
      "extension": [

```



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        "url": "id",
        "valueString": "REM_DIET"
      },
      {
        "url": "prefetch"
      }
    ]
  },
  "description": {
    "text": "High-level goal for diet and lifestyle management"
  },
  "status": "in-progress",
  "meta": {
    "tag": [
      {
        "system": "http://www.c3-cloud.eu/fhir/ValueSet/data-origin",
        "code": "C3DP"
      }
    ]
  },
  "versionId": "1",
  "lastUpdated": "2017-12-08T12:25:03Z"
},
"subject": {
  "reference": "Patient/p-1-demo-a0",
  "display": "Sven Karlsson(a0)"
},
"startDate": "2017-12-08",
"id": "ff61b658-401b-4e31-906b-13586012d608"
},
"search": {
  "mode": "include"
}
}
]
}

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