



# POWER2DM

“Predictive model-based decision support for diabetes patient empowerment”

**Research and Innovation Project**  
**PHC 28 – 2015: Self-management of health and disease and decision support systems based on predictive computer modelling used by the patient him or herself**

## POWER2DM D1.1.

### User Requirements and Use Case Scenarios

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<b>PP</b>	Restricted to other programme participants (including the Commission Services)	
<b>RE</b>	Restricted to a group specified by the consortium (including the Commission Services)	
<b>CO</b>	Confidential, only for members of the consortium (including the Commission Services)	



**POWER2DM CONSORTIUM PARTNERS**

<b>abbrev</b>	<b>Participant organization name</b>	<b>Country</b>
TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	Netherlands
IDK	Institute of Diabetes “Gerhardt Katsch” Karlsburg	Germany
SRDC	SRDC Yazilim Arastirma ve Gelistirme ve Danismanlik Ticaret Limited Sirketi	Turkey
LUMC	Leiden University Medical Center	Netherlands
SAS	SAS Servicio Andaluz de Salud	Spain
SRFG	Salzburg Research Forschungs Gesellschaft	Austria
PD	PrimeData	Netherlands
iHealth	iHealth EU	France

## DEFINITIONS AND ABBREVIATIONS

APE	Action Plan Engine
BCT	Behavior Change technique
DM-QOL,	Diabetes Mellitus – Quality Of Life
DSS	Decision Support System
FFI	Fixed Frequency Interventions. FFIs are self-management interventions for which the frequency is fixed according to defined POWER2DM Care Program and patient is expected to adhere to them by initiating the intervention in the planned periods (ex: like EMPOWER Action Plan Guidance interventions).
HbA1c	Glycated hemoglobin; a form of hemoglobin that is measured primarily to identify the three month average plasma glucose concentration.
Intervention	Any type of feedback, reminder, warning, motivational message, social “digital” interactions to be delivered by POWER2DM Mobile Application or POWER2DM Action Plan Engine during daily life.
JITAI	Just In Time Adaptive Intervention. JITAIs are self-management interventions that are initiated by the POWER2DM SMSS system (specifically recommender engine) automatically during daily life of the patient according to the changing context of the patient.
ODL	Observations of Daily Life
SMSS	Self-Management Support System
Self-management goals and Action Plan	is specified by the patient by using the Action Plan Engine. Both are based on the treatment goals and treatment plan and additionally on the patient’s personal life goals and values (in case they are defined) but are more detailed and may contain additional goals and activities. The Action Plan is what the patient really plans to do. Example self-management goals: 3 times Nordic Walking per week. Example activities: Nordic Walking on Monday, Wednesday and Friday at 18:00, duration: 45 minutes
Treatment goals and treatment plan	Self-management goals can also comprise goals beyond the treatment plan, e.g. planning some time for a hobby. In any case, self-management goals should be in accordance with the personal values. Example self-management goals: Once a month dancing with my wife they are short-term and long-term goals and a detailed plan specified and agreed by physicians and the patient. They would also include recommendations for self-management. Example treatment goals: monitor blood glucose level regularly (long-term), do four measurements per day (short-term) Example treatment plan: Check blood glucose right after wake up, before lunch, before dinner, and before going to bed

## SUMMARY

The main objective of POWER2DM is to develop and validate a personalized self-management support system (SMSS) for Type-1 and Type-2 diabetes patients. The purpose of D1.1. is the definition of scenarios and storyboard to illustrate and facilitate discussion about the POWER2DM SMSS framework for the architecture and the design of the care process for the health professional and especially the support of the self-care process and the glucose management of the patient.

In Chapter 2 the technical applications which construct the POWER2DM system are described in order to visualize how the system may operate (see Figure D1.1.1.). Also general use cases are provided that describe how health professionals and patients may use POWER2DM. Chapter 3 portrays prototypical patients with diabetes in seven personas. The structure of these personas is based on the current workflow in the LUMC (see Table D.1.1.1.) In Chapter 4 two general scenarios are presented based on this general workflow of the LUMC: (a) a scenario AS-IS depicting the current status, and (b) a scenario TO-BE sketching a future workflow with the POWER2DM system. Chapter 5 describes how persona Peter (Type 1 DM) follows the TO-BE scenario in a possible storyboard. This Peter-scenario is explicitly linked to the technical applications and use cases of the POWER2DM system in the step-by-step version. In the step-by-step scenario requirements of the POWER2DM system are classified as not applicable, desirable or essential. In Chapter 6 the same is done for Persona Ana (Type 2 DM) who is less educated and older than Peter. In Chapter 7 the open issues are described that will be resolved in the continuation of the project.

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## 1 PURPOSE

The main objective of POWER2DM is to develop and validate a personalized self-management support system (SMSS) for Type-1 and Type-2 diabetes patients that combines and integrates: (i) a decision support system (DSS) based on interlinked predictive computer models; (ii) automated e-coaching and advice functionalities based on Behavioural Change Theories; and (iii) real-time personal data processing and interpretation. The DSS will be based on existing predictive models that were originally developed primarily for decision support to healthcare professionals, specifically the KADIS short-term plasma glucose prediction model (developed by partner IDK), the T2D-Marvel medium/long-term prediction model (developed by partner TNO in FP7 MISSION-T2D) for diabetes progression, and established long term diabetes-related risk scoring models for diabetes and its comorbidities (described in the literature). The SMSS will provide automated personalized action (care) plans in terms of lifestyle changes and therapy adjustments for short-term optimal metabolic control as well as for medium/long-term prevention of deterioration and diabetes complications, building on the Action Plan Engine developed by partners SRFG and SRDC in FP7 EMPOWER. The SMSS will fully integrate subject-specific health behaviour change interventions to increase adherence of the patients to their personalized care management program. The predictions will be based on real-time personal data monitoring and tracking by integrating existing personal health systems and applications including mobile systems built around self-monitoring devices.

The purpose of D1.1. is the definition of scenarios and storyboard to illustrate and facilitate discussion about the POWER2DM SMSS framework for the architecture and the design of the care process for the health professional and especially the support of the self-care process and the glucose management of the patient. Several approaches can be offered for fostering self-management and behaviour changes for diabetes patients. To decide on these approaches in this task scenarios and storyboards will be specified to define the functional user requirements for the POWER2DM SMSS.

D1.1. starts in Chapter 2 with a description of the technical applications that form the POWER2DM system in order to visualize how the system may operate. This is illustrated in Figure D1.1.1. Next, in Chapter 3 prototypical patients with diabetes are described in seven personas. The structure of these personas is based on the current workflow in the LUMC. Therefore this workflow is described and summarized in Table D.1.1.1. In Chapter 4 two general scenarios are presented based on the general workflow of the LUMC: (a) a scenario AS-IS depicting the current status, and (b) a scenario TO-BE sketching a future workflow with the POWER2DM system. Chapter 5 describes how persona Peter (Type 1 DM) follows the TO-BE scenario in a possible storyboard. This Peter-scenario is explicitly linked to the technical applications of the POWER2DM system in the step-by-step version. In Chapter 6 we do the same for Persona Ana (Type 2 DM) who is less educated and older than Peter. In Chapter 7 the open issues are listed that will be resolved in the continuation of the project.

## 2 DESCRIPTION OF POWER2DM TECHNICAL APPLICATIONS

This chapter provides a general overview of the technical applications that together form the POWER2DM system in part 2.1. In part 2.2, ten general use cases are provided in which users (health professional, patient) use the POWER2DM system.

### 2.1 General description of POWER2DM system

The POWER2DM system is related to two phases in the diabetes care process:

1. **Shared decision making phase:** patient and healthcare professional decide on treatment goals and plans in the health care setting.
2. **Self-Management phase:** patient manages his diabetes in his daily life.

The Shared decision making phase ends with agreed upon treatment goals and plans. These treatment goals and plans are the starting point for the next self-management phase. In this phase these goals and plans are called self-management goals and action plan. These goals and plans are described as follows.

**Treatment goals and treatment plan (committed actions):** short-term and long-term goals and a detailed plan specified and agreed by health care professional and the patient. They would also include recommendations for self-management.

*Example treatment goals:*

- do some moderate physical exercise (long-term goal), at least 150 minutes per week (short-term goal)
- monitor blood glucose level regularly (long-term), do four measurements per day (short-term)

*Example treatment plan:*

- Check blood glucose right after wake up, before lunch, before dinner, and before going to bed

**Self-management goals and Action Plan:** would be specified by the patient by using the POWER2DM Action Plan Engine (APE). Both are based on the treatment goals and treatment plan and additionally on the patient's personal values (in case they are defined) but are more detailed and may contain additional goals and activities. The Action Plan is what the patient really plans to do.

*Example self-management goals:*

- Exercise three times a week

*Example activities:*

- Nordic Walking on Monday, Wednesday and Friday at 18:00, duration: 45 minutes

Self-management goals can also comprise goals beyond the treatment plan, e.g. planning some time for a hobby. In any case, self-management goals should be in accordance with the personal life goals and values.

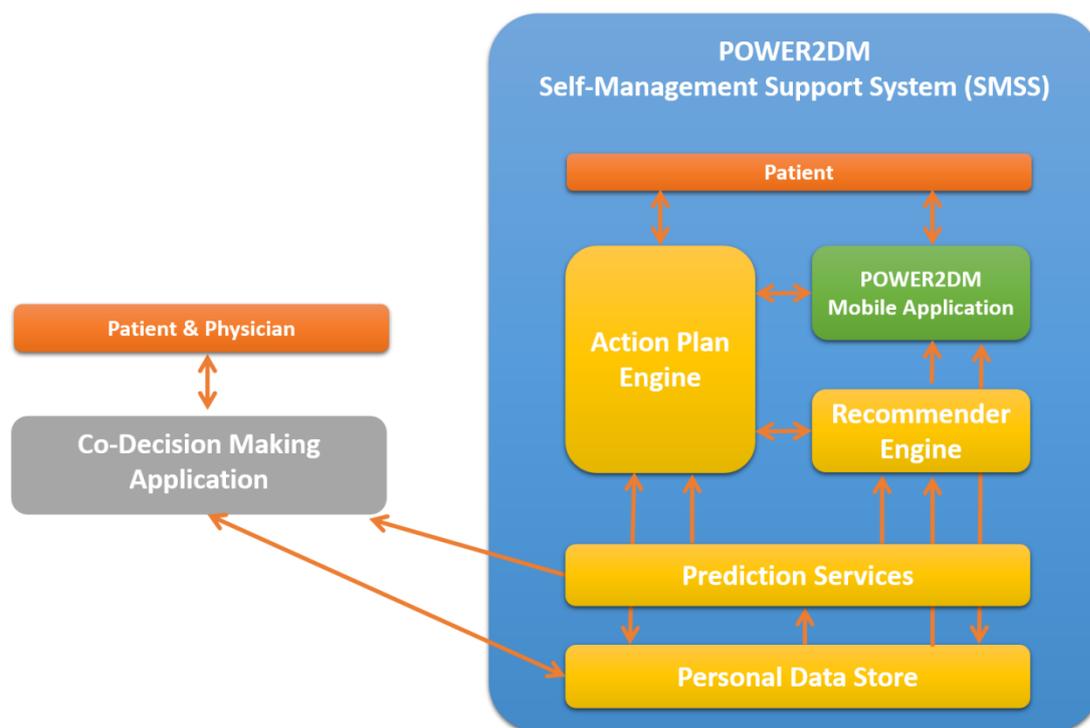
*Example self-management goals:*

- Once a month dancing with my wife

*Example personal life goals and values:*

- To have a life full of vitality by means of running, painting comics and pictures.

In Figure1 the technical applications of the POWER2DM system are depicted. Below the separate applications are described and the responsible partner in the project is mentioned.



**Figure D1.1.1** Portrayal of the technical applications in POWER2DM.

### 2.1.1 Shared decision making phase

**POWER2DM Shared decision Making Application (PrimeData):** This should be an application (with user interfaces) that will support the healthcare professional in order to enter data to POWER2DM (or visualizing patient's data);

- registration of anamnesis
- registration of problem identification
- describe and enter treatment goals and committed actions, informed by using POWER2DM prediction capabilities (POWER2DM Prediction Services) that allow to compare the consequences of various actions to support shared decision making.
- describe and enter barriers and solutions

The final version of the treatment goals and committed actions will be the input for the Action Plan Engine.

### 2.1.2 Self-management phase

**POWER2DM Action Plan Engine (SRFG):** The APE is a complete application (with user interfaces) that supports patient's self-management for:

- Specification of values and if applicable of barriers
- Specification and update of self-management goals (e.g. in case of a new/updated treatment plan or when self-management goals are not realistic)
- Planning of activities periodically (basically weekly)
- Collecting ODL (Observations of Daily Life ) data – in POWER2DM patient data basically will be collected through medical devices and mobile app to be forwarded to the Action Plan Engine
- Evaluation of performance by providing feedbacks periodically (basically weekly)
- Update of activities if feedback indicates that the specific activity does not result in the short-term goal.

The action plan engine uses Fixed Frequency Interventions (FFI). FFIs are self-management interventions for which the frequency is fixed according to a defined POWER2DM Care Program and the patient is expected to adhere to them by initiating the intervention in the planned periods (e.g., like the EMPOWER Action Plan Guidance interventions). For example, weekly review if short-term goals are reached by specified actions.

**POWER2DM Recommender Engine (SRDC):** This is a backend intelligence service aiming to recognize patient's preferences and life-style patterns from collected data. Based on these recognized patterns and preferences it plans Just-In-Time Adaptive Interventions (JITAI; Nahum-Shani et al., 2014). JITAI is self-management interventions that are initiated by the POWER2DM SMSS system (specifically Recommender Engine) automatically during daily life of the patient according to the changing context of the patient. The idea is to adapt the frequency, content and type of interventions accordingly. Examples of JITAI are: (a) motivating message to stimulate the patient to compensate the loaded breakfast with suggestions to manage his blood glucose (e.g., by having a light lunch), or (b) patient only does half his planned exercise and receives a motivating message to finish the complete exercise.

Planned JITAI will be delivered to patients through;

- the dashboard that will be developed in Action Plan Engine
- the push notifications for POWER2DM Mobile Application

**POWER2DM Mobile Application (iHealth):** This is the mobile application to interact with the patient during self-management for

- delivering JITAI interventions
- collection of ODL data

**POWER2DM Prediction Services (TNO and IDK):** All short, mid and long-term predictive models are exposed as web services in a way that are consumable by other relevant components through the internet (KADIS, MARVEL and Risk Score models as prediction service). The prediction services will interact with the following POWER2DM components. The Shared decision making Application will interact to get KADIS and Marvel Predictions and Risk Score calculations during Shared decision making phase. The Recommender Engine will interact with prediction services for JITAI interventions.

**POWER2DM Personal Data Store (SRDC):** This is the component that will store any data used in the system.

## 2.2 Integration of intervention aspects into the Power2DM system

Beside the technical parts, Power2DM consists of intervention aspects that have to be integrated into the Power2DM technical system parts. These intervention aspects are described below.

**Tutorial.** An explanation for users how POWER2DM and its separate components can be used. Based on the smart guidance for the patient, the SMSS should have a flow-based tour for introducing the tool to patients.

**Communication mode.** The way the intervention content will be delivered (e.g., avatar, interactive voice response, text, video). The patient preferences for communication mode are stored in the personal data store and integrated in the decision trees.

**Measurements.** Collection of data (e.g., online questionnaires, wearables, agenda). They will be stored in the personal data store.

**Decision trees.** Specification of which patient will receive what (i.e., measurement, intervention content) and how (i.e., communication mode) in which situation. The decision trees are defined by means of if-then rules (e.g., if the patient will reach a specific value in KADIS, then a warning signal will be sent to the physician). The decision trees are stored in the recommender and action plan engine.

**Triggers.** Moment at which system becomes active (e.g., agenda notification, based on results from prediction services (i.e., KADIS) a signal will be sent to the physician). Recommender engine should recognize trigger from prediction services. The physician should define boundaries for triggers from prediction services for the patient.

**Intervention content.** What will be delivered (e.g., motivational message to patient, warning signal to physician, education, rewards) to the patient. The intervention content should be stored within the recommender engine and action plan engine. The content refers to which behavior change techniques is applied.

### 2.3 Description of how technical applications are used

Five general use cases are described for the shared decision making phase and also 5 use cases for the self-management phase.

#### 2.3.1 Shared decision making phase

##### UC1 – Anamnesis and registration into POWER2DM (TNO, LUMC)

- Visualize data from existing eHealth systems (Lab, patient portal)
- Visualize data from POWER2DM (patient’s accumulated data since last visit)
- Register data to POWER2DM (lab measurements, etc)



This UC1 may differ for each pilot site. For example, as SAS does not have an eHealth system that we can integrate to POWER2DM, we need user interfaces to register data (lab results) to POWER2DM. For other sites automatic integration may be a possibility.

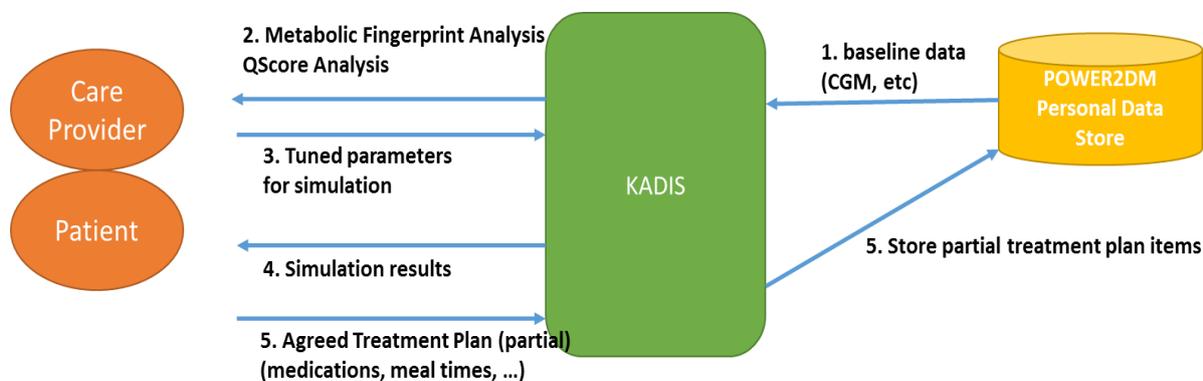
##### UC2 – Problem and Barrier Identification and registration into POWER2DM (TNO, LUMC)

- Registering problems into POWER2DM
- Registering barriers into POWER2DM



**UC3 - KADIS-based Q-Score Analysis and Metabolic Fingerprint Analysis (IDK)**

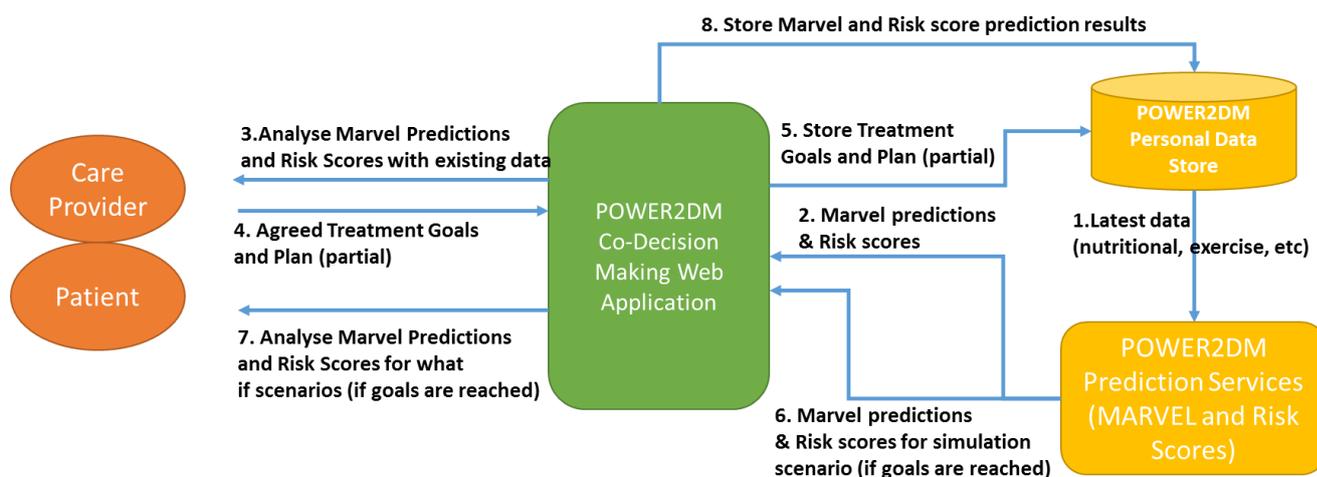
- Metabolic Fingerprint and Q-Score Visualization and Analysis
- Simulating different Treatment plans (medication, dietary and exercise plans)
- Agreeing on the Treatment Plan (partial; in relation to KADIS) and saving it to POWER2DM



KADIS can be used as a standalone application (as shown in the figure) as it is or its user interfaces can be adapted for POWER2DM and integrated into “POWER2DM Shared decision Making Web Application” while KADIS model can be used as a backend prediction service (as a part of the POWER2DM Prediction Services).

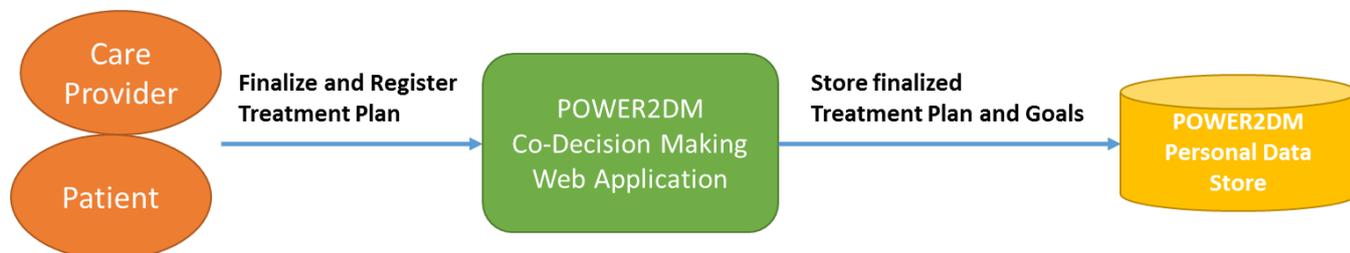
**UC4 – Evaluation of Risks and Outcome Expectancies (by using MARVEL and risk score models) (TNO)**

- Analyzing MARVEL predictions with the existing patient context (latest data and summaries from last self-management phase)
- Analyzing Risk Score predictions with the existing patient context
- Agreeing on the Treatment Goals and Plan (partial; in relation to Marvel and Risk scores) and register it to the POWER2DM
- Analyzing outcome expectancies with Marvel and Risk Score simulations with what if scenarios (if goals are reached)
- Storing all prediction results



**UC5 – Finalizing and Registration of Treatment Plan and Goals into POWER2DM (TNO)**

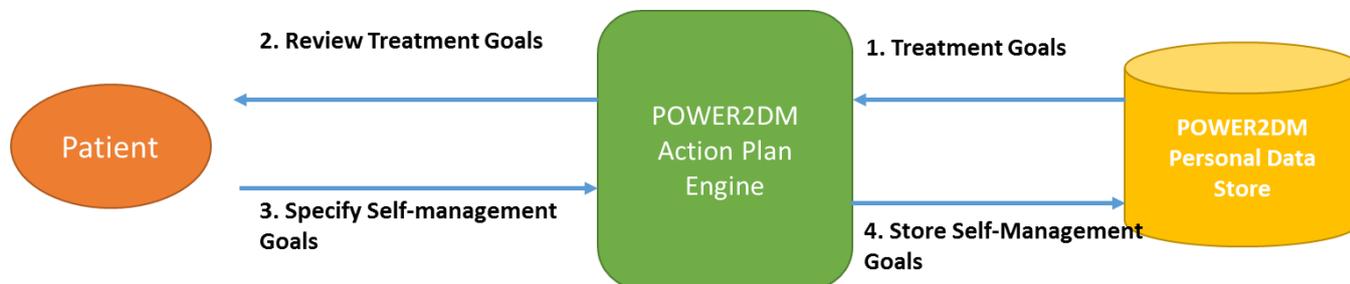
- Review of Treatment Plan and Goals registered in UC3 and UC4. The care provider and patient decide together on the goals (i.e., whether the patient is committed, perceives the goals as feasible, or whether adjustments need to be made) based on shared decision making.
- Agreeing, detailing and registration of remaining parts of Treatment Plan (short-term goals and committed actions including solutions to barriers)



**2.3.2 Self-management phase**

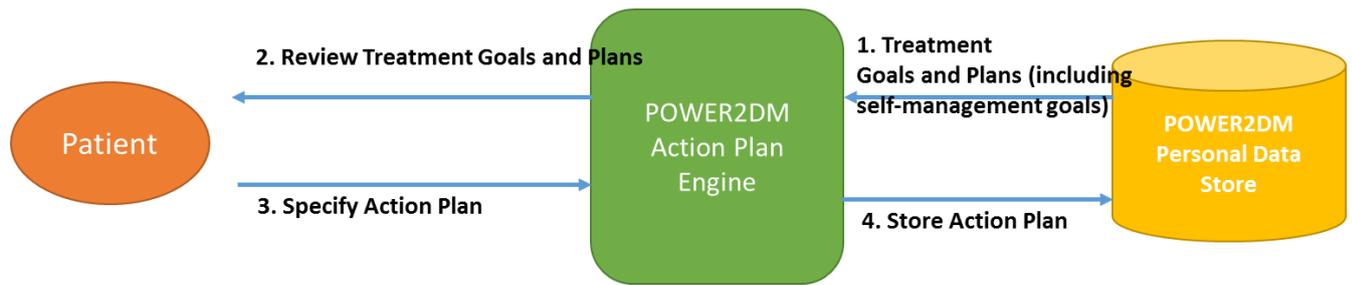
**UC6- Specification/Adjustments of Self-Management Goals (SRFG)**

- Review if Treatment Goals registered in UC5 needs specification or refinement as Self-management Goals. For instance (1) if there is no detailed shared decision making, (2) if there are additional advices e.g., from a diabetes training or from a dietary nurse, (3) if the patient realizes that a goal does not work for him and he has to modify it, or (4) the patient wants to add an additional lifestyle goal not discussed with his doctor. However, the main goal setting happens in UC 5 where the care provider and patient decide together on the goals.
- Check if self-management goals are in line with personal values.
- Registration of Self-management goals (short-term goals).



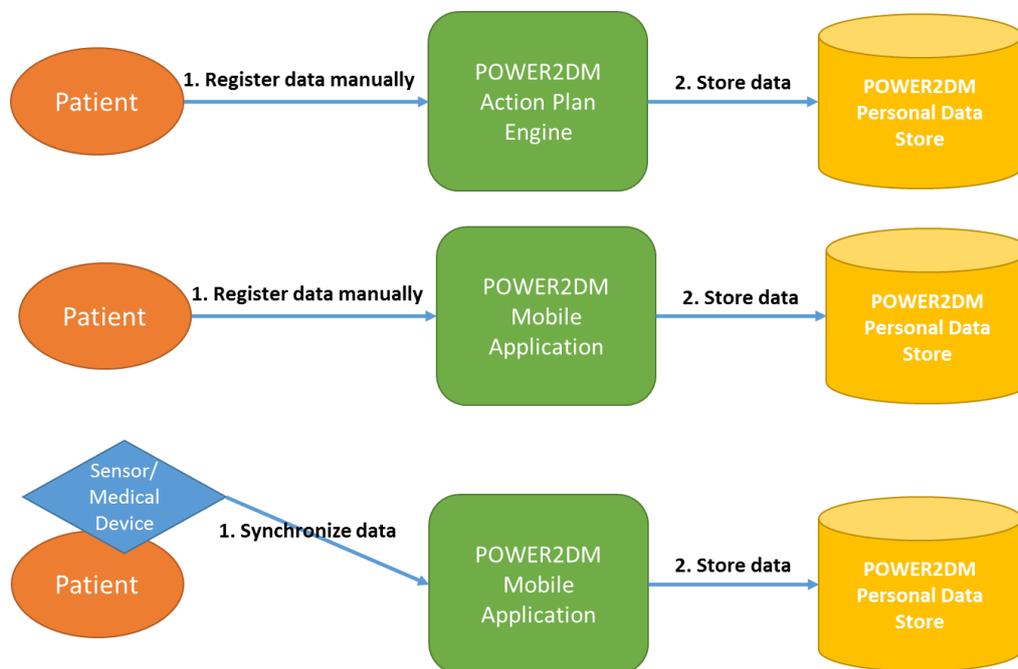
**UC7- Specification/Adjustments of Action Plan (SRFG)**

- Review if Treatment Plans registered in UC5 needs specification or refinement as Self-management Plans.
- Check if there are barriers to execute the self-management plan. If so, suggest action plans to overcome/cope with/resolve these barriers.
- Registration of Self-management actions (committed actions) including solutions to barriers.



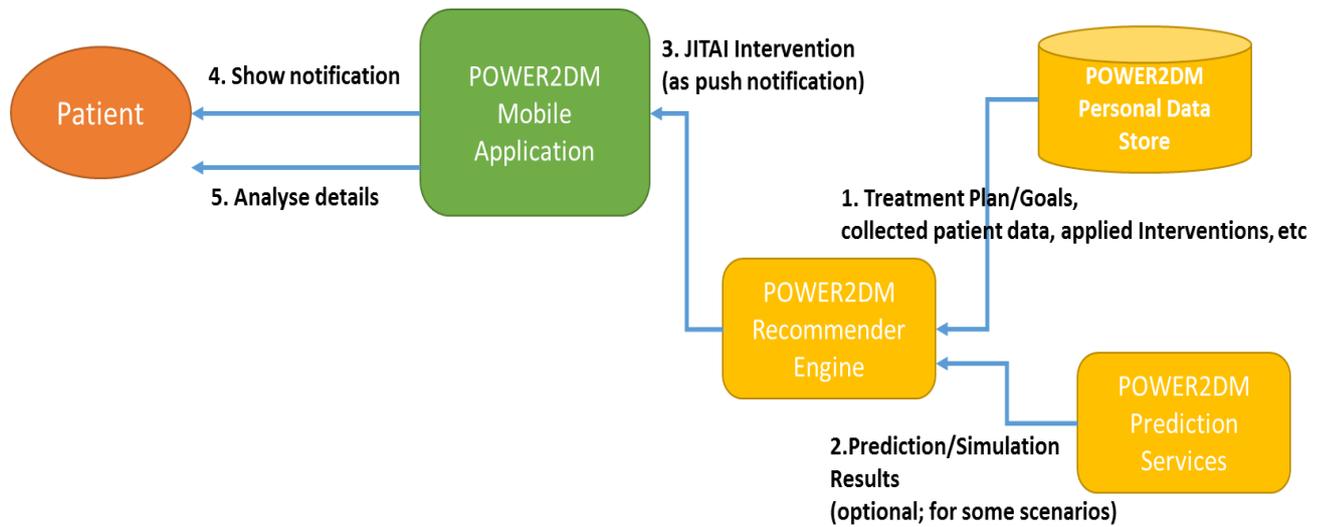
**UC8- Collecting observations of daily life (ODL) from patient (SRFG, TNO, iHealth)**

- Data collection by sensors and medical devices
- Data collection by guided input from patient via POWER2DM Action Plan Engine
- Data collection by guided input from patient via POWER2DM Mobile Application



**UC9- Delivering JITAI interventions at runtime during daily life (SRDC)**

- Collecting information from ODL and Prediction Services
- Based on e.g. Prediction Services provide JITAI



**UC10- Self-evaluation with provided feedbacks (SRFG)**

- Evaluation if actions are executed according to action plan
- Evaluation if self-management goal is reached by executing the action plan
- Evaluation if changes need to be made to self-management goals or action plan
- Loop to step UC6 (action plan cycle)



**Evaluation and Feedback (Shared Decision Making)**

Loop to UC1

### 3 PERSONAS

The personas are representatives of the population of patients with diabetes that may use the POWER2DM system. The personas may have certain needs in their current management of their diabetes that may be fulfilled by the POWER2DM system. In order to satisfy these needs the POWER2DM system has to meet certain requirements. LUMC and SAS described the personas using a structure that is based on the workflow of the LUMC in caring for their patients. In part 3.1. we first describe the workflow in the LUMC and in part 3.2. the seven personas are provided.

#### 3.1 Background workflow LUMC

The LUMC has a behavioural treatment focus on diabetes self-management, meaning that:

- In consultations (with both doctors, nurses and dieticians) they explore which diabetes self-management behaviours could be improved (and explain why HbA1c-levels might be high);
- They evaluate which self-management behaviours a patient wants to improve, and whether there are any barriers to improvement (e.g. knowledge, conflicting life goals, psychological problems);
- After that they formulate behavioural treatment goals (from one consultation to the other), that step-by-step improve the specific self-management behaviour(s).

This behavioural focus on self-management support reflects the evidence-based literature on goal oriented diabetes self-management support. Previous studies indicate that to help a patient successfully self-manage, a holistic picture of the patient is necessary which incorporates medical, psychological, and social factors of the patient and the barriers to self-management that they experience within these domains. Therefore, in the persona's a short description is provided of the patients' diabetes, their previous diabetes self-management experiences, the daily context in which the self-management is performed and their psychological health. This approach is described in more detail here below and in Table D1.1.1. This table is intended as a general overview of the psychological processes that underlie self-management. The table is an example of the medical psychological way of screening and working in the LUMC (Leiden, the Netherlands); it is not comprehensive.

More specifically the current flow of care at the LUMC is:

1. The doctor and patient agree upon a treatment plan with long-term goals (based on medical needs and patient values)
2. The doctor and patient agree upon short-term goals with committed action plans to reach the long-term goals
3. The patient attempts to achieve these plans
4. Patient returns for quarterly/annual check-up, success is evaluated, problems are identified and the short-term goals and committed action plans are adjusted

In Table D1.1.1. this process is visualised. This table D1.1.1 is developed by the LUMC (Dr. S. Huisman). It should be noted that this table is more relevant for T1DM patients than T2DM (for example no weight/cholesterol columns), but this table will be expanded. In this table if everything is going well then the patient never leaves the green rows and everyone is happy. However, when things do not go well then we need to see *Where* it didn't work, *What* didn't work, and we need to ask *Why*?

Table D1.1.1. Layers of DM Self-management Goals and Psycho-Social Barriers: way of screening and working in the LUMC for Type 1 DM (© DM DPT.LUMC) with adjustments for Type 2 DM from SAS.

<b>Ultimate Goal</b>	Optimisation HbA1c (= lowering risk of complications) and DM-QOL This is a long term goal												
Doctor and Patient Agree on Long Term and Short Term goals and a Self-Management Plan (Actions Plans/Committed Actions to achieve them)													
Review Outcomes of Self-Management Plan: If plan is working then maintain plan, if it is not then identify problem and adjust plan													
<b>Where?</b>													
<b>Problem area (general)</b>	<b>Insulin/Medication</b>				<b>Carbohydrates</b>		<b>Glucose monitoring</b>		<b>Exercise</b>		<b>Stress*</b>		
<b>What?</b>													
<b>Problem (specific)</b>	<b>Too little</b>		<b>Too much</b>		<b>Too few</b>		<b>Too much</b>		<b>Too little</b>		<b>Too much</b>	<b>(physical) Stress too high</b>	
	Low Dose	Low Frequency	High Dose	High Frequency									
<b>Why?</b>													
<b>Psychological Barrier Specific</b>	Fear hypo's	Fear hypo's	Fear hypers	Fear hypers	Fear hypers	Fear hypo's		Fear hypo's/hypers	Fear hypo's	Fear hypers			
	Fear weight	Fear weight			Fear weight	Eating problem				Fear weight			
		Fear injections (when on insulin/injectables)						Fear 'needles'					
		Negative affect (NA)			Negative affect (NA)	Negative affect (NA)	Negative affect (NA)		Negative affect (NA)		Negative affect (NA)		
		Fear Disclosure						Fear Disclosure					
		Sensation of "Too many pills"	<b>Fear of insulin</b>					Not reimbursed		<b>Sedentary habit for too long</b>			
		Lack of acceptance of the new disease					<b>Difficulty to engage in a lifestyle change</b>	Fear to realize bad accomplish of treatment		<b>Difficulty to engage in a lifestyle change</b>			

<b>General</b>		Inability to carry on his/her treatment (especially in elderly)		Inability to carry on his/her treatment (specially in elderly)	Overwhelmed by new status. Not able to prepare proper diet (elderly)	Overwhelmed by new status. Not able to prepare proper diet (elderly)	Gave up on using glucose monitors (feeling unable)		Fear to have a physical accident (elderly).		
		Forgetting			Forgetting		Forgetting		Forgetting		
		Conflicting life goals *			Conflicting life goals *	Conflicting life goals *	Conflicting life goals *		Conflicting life goals *		Conflicting life goals *
	DM self-efficacy DM health beliefs DM knowledge/literacy/problem solving skills Locus of control Motivation										
<b>Socio-demographic barrier</b>	Lack of social support Comorbidity DSM: Axis IV problems (financial, work, relationship, family issues)										

An example in a type 1 DM is the long-term goal to monitor blood glucose level regularly, and the short-term goal is four measurements per day. The patient tries to execute this action plan for two weeks and then evaluates success. After two weeks, the patient has only checked his glucose four times a day on five days out of the past 14 day. So the *Where* is Glucose monitoring, and the *What* is too little, so now we need to ask the patient *Why* he was not able to monitor his glucose four times per day. Without the *Why* we can only recommend that the person change the *What* and that doesn't usually work (in this case it would just be telling the patient to monitor more). If we look at Tabel D1.1.1. we can see specific psycho-social barriers that are related to too little glucose monitoring. So we ask questions about these areas (these are just hypothetical examples and do not cover all the possible questions):

1. Fear of needles: What do you think of when you think about using a needle?
2. Negative affect: When you think about checking your blood glucose, how do you feel? (good, happy, neutral, angry, sad, upset, scared, disgust)
3. Fear of disclosure: Do you feel comfortable telling other people what is involved in your diabetes care? Can you tell your partner? Friends? Children? Colleagues?
4. Forgetting: Did you forget about your plans to monitor your blood glucose? (NOTE: forgetting is often the result of negative affect and used as an excuse to cover underlying problems so extra questions if this is indicated are needed to evaluate the actual problem, this is similar to problems with motivation)
5. Conflicting life goals: Did you have problems fitting glucose monitoring into your schedule?
  - If there is no clear reason based on these answers then we move on to ask questions about general barriers to action.
  - If there are no clear general barriers then we move to socio-demographic barriers. However, socio-demographic barriers are beyond the scope of POWER2DM.

Based on the *Why*, we can recommend action plans. In the example, the patient says that he is not scared of needles, feels fine when thinking about checking his blood glucose, did not forget, and had the time, but he doesn't feel like he can be honest with his partner about his diabetes care. An advise could be that the patient talks with his partner, or having small communication training modules for the patient to help him to learn how to talk about these issues. Based on what the patient chooses, the self-management plan could be to complete the communication modules and having the patient check his glucose in the mornings with his partner present.

An example in a type 2 DM is the long-term goal of 80% adherence to the oral antidiabetic treatment, and the short-term goal is pill accounting diary. The patient tries to execute this action plan for two weeks and then evaluates success. After two weeks, the patient has only filled correctly his/her diary 8 days of the 14 days. So the *Where* is Insulin/Medication, and the *What* is too little, so now we need to ask the patient *Why* he was not able to correctly monitor his/her treatment. We then consult Table D1.1.1. to ascertain specific psycho-social barriers that relate to too little medication. So we ask questions about these areas (again, these are just hypothetical examples and do not cover all the possible questions. Furthermore, some of these do not apply. For example "fear injections" in a patient in oral treatment):

1. Fear of hypo's: Have you ever experienced a hypo? Did you recently? How did that affect to you?
2. Fear of weight: Do you think that you have gained some weight with the antidiabetic treatment?
3. Negative affect: How do you feel just before opening your pill diary? (good, happy, neutral, angry, sad, upset, scared, disgust)
4. Fear of disclosure: Do you feel comfortable telling other people what is involved in your diabetes care? Can you tell your partner? Friends? Children? Colleagues?
5. Sensation of "Too many pills": How happy are you with your treatment? Does it interfere with your regular life? Have you noted any adverse event with the antidiabetic treatment?
6. Lack of acceptance of the new disease: Have you learned to live with Diabetes? Do you think that adherence to treatment is worthy?
7. Capability to execute his/her treatment (specially in elderly): Do you easily recognize your pills by color/shape? Please tell me by memory what pills do you have to take at breakfast, lunch and dinner. What do you have to do if you forget to take a pill?

8. Forgetting: Did you forget about your plans to control medication?
9. Conflicting life goals: Did you have problems fitting control medication into your schedule? Do you feel achy because of having to fill one pill diary?
  - General barriers in this example are quite similar as in the first example above

Reviewing the responses to *Why*, we can recommend an action plan for this second example. The patient says that she had not any hypo, she thinks that she may have earned some weight, although she hasn't weighted herself for one month, feels a little uneasy when opening the diary, because she knows that she hasn't been able to fill it always, and it reminds her that she's failing. She feels a little guilty, and avoids to tell it someone. She misses the time when she was not a diabetic. In this case, it seems that a lack of ability to control medication can be the cause. We can recommend her to buy a pillbox, and talk to the pharmacist to fill it. The self-management plan could be to check the weekly percentage of correct medication taking with the pillbox, and stick a little sticker in the freeze for every week with a correct percentage upper 80%.

### 3.2 Personas

LUMC developed personas Peter, Julia, Simon, Barbara and Johan, and SAS developed personas Ana and Rafael. In the table the experience of how the persona manages his/her Diabetes strongly affects the quality of his/her life.

<b>PETER (43)</b>	
<b>DM parameters</b>	
Diabetes (time since diagnosis)	Type 1 (24 years)
Comorbidity & complications	None
HbA1c/BMI	HbA1c = 56 mmol/mol (7.3%) / BMI = 24
DM medication/devices	Insulin pump with Aspart (Novorapid/Novolog)
<b>DM SM Experience</b>	
Hyper/Hypo-glycaemia	- Feels hindered by hyper- and hypo-glycaemia, more than previously
Self-management (SM) problem	- Decrease of glucose monitoring - Insulin injections not as regular or precise as previously
Psychological barrier to DM SM	- Negative affect: feels sad about continuous burden of DM so he avoids confrontation with high/low blood glucose levels by not monitoring these
Conflicting life & health goals	- Hypo's interfere with sports, social life, work, and relationship (sex) - Hypers decrease energy at work and at home
<b>Socio-demographics</b>	
Social environment & support	- Happily married, supportive wife, 4 kids (between 7-12 yrs of age) - Friends at soccer (accepting and supporting) - Friends from university (accepting and supporting)
Work/education	- Works as an accountant for a consultancy company, 45 hrs. a week - Higher education (University level)
Sports/Hobbies	- Enjoys running (10 km.), swimming - Writing/drawing comics
<b>Psychological health</b>	
Strengths	- Positive, intelligent, reflective, open
Issues	- Feels guilty when not "following recommendations"
<b>Care plan</b>	
Treatment goal	- To reduce hindrance of hyper- and hypoglycaemia in sports, work, family and social life activities
Committed actions	- Glucose monitoring before- sports, meetings and family events - Carrying quick carbs

<b>JULIA (26)</b>	
<b>DM parameters</b>	
Diabetes (time since diagnosis)	Type 1 (16 years)
Comorbidity & complications	None
HbA1c/BMI	HbA1c = 73 mmol/mol (8.8%) / BMI = 22
DM medication/devices	Aspart (Novorapid/Novolog) (3x), Glargine (Lantus) (1x)
<b>DM SM Experience</b>	
Hyper/Hypo-glycaemia	- Blood sugars have been (consistently) high for the past few years with associated reduction in energy levels - Has experienced serious hypoglycemic episode (ambulance)
Self-management (SM) problem	- Frequent (excessive) glucose monitoring (> 10 times a day) - Insulin dosage insufficient
Psychological barrier to DM SM	- Fear of hypoglycaemia after experiencing a serious hypo (ambulance) - Avoidance of 'low' blood sugars by intentionally keeping blood glucose levels (and hbA1c) high
Conflicting life & health goals	- Hypers reduce energy at work and at home - Fear of hypo's interferes with driving a car, sports, and outdoor traveling. - Wants to have children within next few years, but knows her HbA1c needs to be below 53 before she is "allowed" to try to get pregnant
<b>Socio-demographics</b>	
Social environment & support	- Lives together with boyfriend; boyfriend doesn't really know about constant high blood sugars; DM is not really addressed in their communication - Strong social network with friends; doesn't like talking about DM with her friends.
Work/education	- Works part-time (3 days) as a waitress/hostess in a restaurant
Sports/Hobbies	- Enjoys dancing (ballet) - Reading and likes outdoor traveling
<b>Psychological health</b>	
Strengths	- Outgoing, hardworking, motivated
Issues	- Fearful, not really able to talk about emotions involved in DM SM
<b>Care plan</b>	
Treatment goal	- To reduce physical hindrance of hyperglycaemia (energy, fatigue, low mood) - To reduce fear of hypo's
Committed actions	- Increase of insulin doses when she is at home with her boyfriend in the weekend

<b>SIMON (38)</b>	
<b>DM parameters</b>	
Diabetes (time since diagnosis)	Type 1 (30 years)
Comorbidity & complications	- No comorbidity - DM related complications: background retinopathy and (mild) (peripheral) neuropathy
HbA1c/BMI	HbA1c = 68 mmol/mol (8.3%) / BMI = 27
DM medication/devices	Aspart (Novorapid/Novolog) (3x), Glargine (Lantus) (1x)
<b>DM SM Experience</b>	
Hyper/Hypo-glycaemia	- Blood sugars have been (consistently) high for the past few years with associated reduction in energy levels
Self-management (SM) problem	- Insufficient glucose monitoring (once a week) - “Forgets” to inject (a regular dose of) insulin at least once a day
Psychological barrier to DM SM	- Negative affect and “forgetting” - Feels guilty when not self-managing but confrontation with DM and frequent high blood sugars (by means of measuring glucose levels or injecting insulin) is too upsetting which leads to avoidance
Conflicting life & health goals	- Hypers reduce energy at work and at home - Feels DM SM is an enormous burden: QOL is low, doesn't enjoy life
<b>Socio-demographics</b>	
Social environment & support	- Single; previous relationship was negatively influenced by constant arguments about blood sugars - Not many friends but enjoys contact with colleagues - Good relationship with older brother
Work/education	- Works in IT
Sports/Hobbies	- Used to play rugby and tennis, but has a sedentary lifestyle at this moment - Doesn't really enjoy going out anymore
<b>Psychological health</b>	
Strengths	- Intelligent, friendly,
Issues	- Is not very open about DM and negative emotions, pessimistic
<b>Care plan</b>	
Treatment goal	- To reduce the burden of having DM
Committed actions	- Measuring of fasting glucose every morning - Set alarm in smartphone for injecting insulin at lunchtime

<b>BARBARA (58)</b>	
<b>DM parameters</b>	
Diabetes (time since diagnosis)	Type 2 (9 years)
Comorbidity & complications	Asthma, Rheumatoid Arthritis
HbA1c/BMI	HbA1c = 59 mmol/mol (7.6%) / BMI = 31
DM medication/devices	oral anti-diabetics Glimepiride (Amaryl) 8 mg.
<b>DM SM Experience</b>	
Hyper/Hypo-glycaemia	- Blood sugars are increasing, despite maximum oral anti-diabetics (Sulfanylurea)
Self-management (SM) problem	- Diet is high in (quick) carbohydrates - Very sedentary lifestyle
Psychological barrier to DM SM	- Negative affect: low mood and low energy - Energy 'too low' to cook healthy dinners and/or to exercise
Conflicting life & health goals	- Hypers decrease energy: not being able to walk longer distances - Feeling too low (mood) to enjoy nice things in life...
<b>Socio-demographics</b>	
Social environment & support	- Married to Stan, 2 (adult) daughters, and 1 grandson - Partner is not really supportive. He recently lost his job, and needs her attention and support to cope with that. He never asks about her health or her visits to the hospital. - Barbara feels lonesome, but never acts on this by inviting or calling people (e.g. her sisters)
Work/education	- Used to work as a secretary for a small company, 28 hrs. a week. - No work in previous 5 years because of her health issues
Sports/Hobbies	- Enjoys playing cards - Walks her dog every day (less than 500 m).
<b>Psychological health</b>	
Strengths	- Humorous, outgoing
Issues	- Little disclosure about emotional issues - Not able to generate support
<b>Care plan</b>	
Treatment goal	- To "feel better" (more energy, less fatigue), - Be able to perform more activities/become more active
Committed actions	- Will read on the internet about the PALEO-diet and ways to reduce the amount of quick carbs - Buying a pedometer -> Will try to walk her dog 2x a day, at least 3 times a week.

<b>JOHAN (67)</b>	
<b>DM parameters</b>	
Diabetes (time since diagnosis)	Type 2 (since a few months)
Comorbidity & complications	None
HbA1c/BMI	HbA1c = 48 mmol/mol (6.6%) / BMI = 29
DM medication/devices	No medication yet. Lifestyle changes recommended.
<b>DM SM Experience</b>	
Hyper/Hypo-glycaemia	Slightly elevated blood sugars in the past few months.
Self-management (SM) problem	- Diet is high in both carbohydrates and fat - Sedentary lifestyle
Psychological barrier to DM SM	Diabetes self-management knowledge and skills are poor. Doesn't really understand why the lifestyle changes are needed, and how they would help him. He feels fine.
Conflicting life & health goals	- Former truck driver. Used to eat a lot of snacks and quick meals. - Has a strong social network and feels 'good food' (snacks) should be part of every social event.
<b>Socio-demographics</b>	
Social environment & support	- Married to Pauline, 3 (adult) sons, and 4 grandchildren - Partner prepares meals with fresh (healthy) ingredients, but also likes to spoil her husband with e.g. cake, chips and sausages. Starting to understand more about need of lifestyle changes.
Work/education	- Used to work as a truck driver, 50 hrs. a week. - Stopped working, 3 years ago.
Sports/Hobbies	- Enjoys being around friends, watching football (soccer) - Enjoys working in the garden (only physical activity)
<b>Psychological health</b>	
Strengths	- Strong and autonomous man, easy to interact with
Issues	- Still figuring out what diabetes is all about, and why it is important - Feels that his health is not something to talk or (even think) about
<b>Care plan</b>	
Treatment goal	- Increase diabetes self-management knowledge and skills - Improve knowledge on tasteful and easy healthy snacks
Committed actions	- Will bring his wife to the next consultation, so that she can also be informed about dietary changes - Buying a pedometer -> Will try to step at least 5000 steps a day.

<b>ANA (66)</b>	
<b>DM parameters</b>	
Diabetes (time since diagnosis)	Type 2 (12 years)
Comorbidity & complications	Coronary Disease Hypertension Dyslipidemia
HbA1c/BMI	HbA1c = (7.9%) / BMI = 34
DM medication/devices	Metformin, Dapaglyfozin, Glargine (Lantus) (1x)
<b>DM SM Experience</b>	
Hyper/Hypo-glycaemia	- Loss of glycemic control. Normally hyperglycemic
Self-management (SM) problem	- Unable to calculate Glargine dose changes when needed
Psychological barrier to DM SM	- Too many medications to her opinion. - Used to voluntarily skip some doses of random medications - Thinks that medications may hurt her
Conflicting life & health goals	- Afraid of cardiovascular events. Sister suffered stroke at young age with great disability - Afraid to suffer a hypo when taking care of their granddaughters in the morning
<b>Socio-demographics</b>	
Social environment & support	- Widow - Lives with one of her adult daughters, who wants to help, but is not very confident in her knowledge
Work/education	- Never worked
Sports/Hobbies	- None - Enjoys watch TV and taking care of the kids
<b>Psychological health</b>	
Strengths	- Devoted to family
Issues	- Doesn't pays much attention to self-care
<b>Care plan</b>	
Treatment goal	- Reduce cardiovascular risk
Committed actions	- Commit of daughter to help her - Adhere to medication - Do some exercise

<b>RAFAEL (61)</b>	
<b>DM parameters</b>	
Diabetes (time since diagnosis)	Type 2 (6 years)
Comorbidity & complications	Hypertension, Dyslipidemia
HbA1c/BMI	HbA1c = (8.1%) / BMI = 31
DM medication/devices	oral anti-diabetics Metformin and Sitagliptin
<b>DM SM Experience</b>	
Hyper/Hypo-glycaemia	- Hypos in the past when in Sulfonilureas treatment. Since then, afraid of hypos - Currently increasing fasting glucose, no postprandial measurements around 190 mg/dL
Self-management (SM) problem	- Needs counselling on diet. - He believes that he performs physical exercise, but it is rather irregular - Drinks 1-2 beer/day - He doesn't remember very well if he takes his pills
Psychological barrier to DM SM	- Negative affect and "forgetting" - Feels unable to control all his medication. Hesitated to take control.
Conflicting life & health goals	-Tried to control his disease, but he thinks that he can do nothing, because is the physician who has to take the control.
<b>Socio-demographics</b>	
Social environment & support	- Married to Manuela, 1 (adult) daughter. - Her wife is supportive, but she doesn't have correct formation on dietary needs for him. - They live alone, daughter is away, and use to stay at home with little social life.
Work/education	- Farmers.
Sports/Hobbies	- Work in the garden, likes farming lettuces and tomatoes
<b>Psychological health</b>	
Strengths	- Constant
Issues	- He doesn't like to talk about himself - Reticent to engage in new challenges
<b>Care plan</b>	
Treatment goal	- Lose some weight - Making feel more confident on the control of the disease - Lose the fear to smartphone
Committed actions	- Adhere to lifestyle - Start to use his smartphone

## 4 GENERAL SCENARIOS

Two general scenarios have been developed based on the flow of care in the LUMC (see part 3.1 and Table D1.1.1.). Part 4.1 describes the current flow of care in an AS-IS scenario. In part 4.2. the scenario TO-BE is described in which the POWER2DM system is incorporated in the flow of care for patients with diabetes. This is indicated by yellow marking. In the TO-BE scenario desirable and essential requirements of POWER2DM are described.

### 4.1 AS-IS scenario

#### 4.1.1 Shared decision making phase

##### 1) Anamnesis (WHERE? & WHAT?)

- a. Patient visits care provider (GP, internist, diabetes nurse, general practice-based nurse specialist) with complaints / Care provider invites patient for an extra check / There is a quarterly or annual check-up
- b. Patient and care provider make an appointment for anamnesis
- c. Anamnesis via online patient portal and lab research
  - i. DM-QOL, HbA1c
  - ii. WHERE?
    1. Insulin/medication → WHAT? Dose too low/high, frequency too low/high
    2. Carbohydrates → WHAT? Too little/much
    3. Glucose monitoring → WHAT? Too little/much
    4. Exercise → WHAT? Too little/much
    5. Stress → WHAT? (physical) Stress too high
    6. Weight → WHAT? Too low/high
    7. Cholesterol → WHAT? Too high
    8. Other risk factors → WHAT? CVD risk factors (e.g., hypertension) and specific diabetes complications present (e.g., foot complaints)
- d. Patient discusses results of the anamnesis with the care provider and determines whether there is a problem or not
  - i. No problem → Caregiver and patient agree for quarterly/annual check-up and make an appointment
  - ii. Problem (HbA1c/weight/cholesterol too high combined with inaccurate values on other anamnesis factors) → Problem identification (WHY?)

##### 2) Problem identification (WHY?)

- a. Caregiver and patient identify problem-specific barriers
  - i. Type of barriers
    1. Specific psychological barriers → Fear hypo's, fear hyperts, fear weight, fear injections, fear 'needles', fear disclosure, eating problem, negative affect, forgetting, conflicting life goals
    2. General psychological barriers → DM self-efficacy, DM health beliefs, DM knowledge, literacy, problem solving skills, locus of control, motivation
    3. Socio-demographic barriers → Lack of social support, comorbidity, DSM axis IV problems (financial, work, relationship, family issues)
  - ii. Relation of problem to problem-specific barriers
    1. WHERE? Insulin → WHAT? → Dose too low → WHY? Fear hypo's, fear weight, general psychological barriers and/or socio-demographic barriers
    2. WHERE? Insulin → WHAT? → Frequency too low → WHY? Fear hypo's, fear weight, fear injections, negative affect, fear disclosure, forgetting, conflicting life goals, generic psychological barriers and/or socio-demographic barriers

3. WHERE? Insulin → WHAT? Dose too high → WHY? Fear hyperts, generic psychological barriers and/or socio-demographic barriers
4. WHERE? Insulin → WHAT? Frequency too high → WHY? Fear hyperts, generic psychological barriers and/or socio-demographic barriers
5. WHERE? Carbohydrates → WHAT? Too little → WHY? Fear hyperts, fear weight, negative affect, forgetting, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
6. WHERE? Carbohydrates → WHAT? Too much → WHY? Fear hypo's, eating problem, negative affect, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
7. WHERE? Glucose monitoring → WHAT? Too little → WHY? Fear needles, negative affect, fear disclosure, forgetting, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
8. WHERE? Glucose monitoring → WHAT? Too much → WHY? Fear hypo's/hyperts, generic psychological barriers and/or socio-demographic barriers
9. WHERE? Exercise → WHAT? Too little → WHY? Fear hypo's, negative affect, forgetting, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
10. WHERE? Exercise → WHAT? Too much → WHY? Fear hyperts, fear weight, generic psychological barriers and/or socio-demographic barriers
11. WHERE? (physical) stress → WHAT? Too high → WHY? Negative affect, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
12. WHERE? Cholesterol → WHAT? Saturated fat consumption too high → WHY? Eating problem, negative affect, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
13. WHERE? Other risk factors present → WHAT? Hypertension → WHY?
14. WHERE? Other risk factors present → WHAT? specific diabetes complications → WHY?

### 3) Recommendations

- a. Caregiver and patient agree upon treatment plan with ultimate, mid/long-term goals (based on medical needs and patient values ).
  - i. Ultimate goal is optimization of HbA1c and DM-QOL.
  - ii. Mid-/long-term goals (WHERE?) are optimization of insulin/medication, carbohydrates, glucose monitoring, exercise, stress, weight and/or cholesterol.  
Examples:
    1. Improve insulin/medication adherence
    2. Reducing/counting carbohydrates
    3. Monitor blood glucose regularly
    4. Increasing exercise
    5. Reducing stress
    6. Reducing weight
    7. Reducing cholesterol
    8. Reduce blood pressure
    9. Reduce specific diabetes complications
- b. Caregiver and patient agree upon solution for barriers (WHY?). Example:
  - i. Barrier → Patient regularly forgets blood glucose monitoring. Solution → Patient will set telephone alarm at agreed times right before monitoring.

### 4) Action planning

- a. Caregiver and patient agree upon short-term goals (i.e., reduce (specific/general) psychological barriers; WHY?) with committed action plans to reach the mid-/long-term goals. Examples:
  - i. Ultimate goal: optimizing DM-QOL by reducing hindrance of hyper- and hypoglycaemia daily

Mid-/long-term goal: making blood glucose monitoring a daily habit within the next 6 months by determining and keeping set times at which monitoring occurs

Short-term goal: increase blood glucose measurements from 1 to 4 times daily when wake up, before lunch, before dinner, before going to bed within the next month

Barrier: regularly forgetting to monitor blood glucose

Action plans: set alarm in smartphone at fixed times (wake up, before lunch, before dinner, before going to bed), preparing a bag with monitoring equipment, bringing monitoring bag everywhere (home, work, when with friends).

- ii. Ultimate goal: optimizing HbA1c by increasing strenuous physical activity

Mid-/long-term goal: making strenuous physical activity 3 times a week for 30 minutes per time a habit within the next 6 months by means of running, and increase activity from one day of 30 minutes strenuous physical activity per week, to 3 days per week of 30 minutes strenuous physical activity in the next 3 months

Short-term goal: increase running 3 km in 25 minutes to 5 km in 30 minutes on Monday-Wednesday-Friday while my partner is putting the kids to bed in the next month

Barriers: no time for running because of young children, no support from partner

Action plans: ask partner to put the kids to bed at Monday-Wednesday-Friday, download run schema at My Asics to run 5 km in 30 minutes within the next month, buy new running clothes.

#### 4.1.2 Self-management phase

##### 5) Monitoring and self-management

- a. Patient attempts to achieve these action plans
- b. Patient monitors successes and failures
- c. Patient adapts action plans in case of failure
- d. Patient makes appointment with care giver in case of complaints (loop to step 1)

##### 6) Evaluation and feedback

- a. Patient returns to the caregiver for quarterly/annual check-up (loop to step 1)
- b. Evaluate successes and failures

## 4.2 TO-BE scenario

### 4.2.1 Shared decision making phase

The added value of POWER2DM in the TO-BE scenario is highlighted in yellow.

#### 1) Anamnesis (WHERE? & WHAT?)

- a. Patient visits care provider (GP, internist, diabetes nurse, general practice-based nurse specialist) with complaints / Care provider invites patient for an extra check / There is a quarterly or annual check-up
- b. Patient and care provider make an appointment for anamnesis
- c. Anamnesis via online patient portal and lab research
  - i. DM-QOL, HbA1c
  - ii. WHERE?
    1. Insulin/medication → WHAT? Dose too low/high, frequency too low/high
    2. Carbohydrates → WHAT? Too little/much
    3. Glucose monitoring → WHAT? Too little/much
    4. Exercise → WHAT? Too little/much
    5. Stress → WHAT? (physical) Stress too high
    6. Weight → WHAT? Too low/high

7. Cholesterol → WHAT? Too high
  8. Other risk factors → WHAT? CVD risk factors (e.g., hypertension) and specific diabetes complications present (e.g., feet complaints)
  - d. Patient discusses results of the anamnesis with the care provider and determines whether there is a problem or not
    - i. No problem → Caregiver and patient agree for quarterly/annual check-up and make an appointment
    - ii. Problem (HbA1c/weight/cholesterol too high combined with inaccurate values on other anamnesis factors) → Problem identification (WHY?)
  - e. Registration of anamnesis into POWER2DM
- 2) Problem identification (WHY?)**
- a. Caregiver and patient identify problem-specific barriers (BCT – prompt barrier identification)
    - i. Type of barriers
      1. Specific psychological barriers → Fear hypo's, fear hypers, fear weight, fear injections, fear 'needles', fear disclosure, eating problem, negative affect, forgetting, conflicting life goals
      2. General psychological barriers → DM self-efficacy, DM health beliefs, DM knowledge, literacy, problem solving skills, locus of control, motivation
      3. Socio-demographic barriers → Lack of social support, comorbidity, DSM axis IV problems (financial, work, relationship, family issues)
    - ii. Relation of problem to problem-specific barriers
      1. WHERE? Insulin → WHAT? → Dose too low → WHY? Fear hypo's, fear weight, general psychological barriers and/or socio-demographic barriers
      2. WHERE? Insulin → WHAT? → Frequency too low → WHY? Fear hypo's, fear weight, fear injections, negative affect, fear disclosure, forgetting, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
      3. WHERE? Insulin → WHAT? Dose too high → WHY? Fear hypers, generic psychological barriers and/or socio-demographic barriers
      4. WHERE? Insulin → WHAT? Frequency too high → WHY? Fear hypers, generic psychological barriers and/or socio-demographic barriers
      5. WHERE? Carbohydrates → WHAT? Too little → WHY? Fear hypers, fear weight, negative affect, forgetting, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
      6. WHERE? Carbohydrates → WHAT? Too much → WHY? Fear hypo's, eating problem, negative affect, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
      7. WHERE? Glucose monitoring → WHAT? Too little → WHY? Fear needles, negative affect, fear disclosure, forgetting, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
      8. WHERE? Glucose monitoring → WHAT? Too much → WHY? Fear hypo's/hypers, generic psychological barriers and/or socio-demographic barriers
      9. WHERE? Exercise → WHAT? Too little → WHY? Fear hypo's, negative affect, forgetting, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
      10. WHERE? Exercise → WHAT? Too much → WHY? Fear hypers, fear weight, generic psychological barriers and/or socio-demographic barriers
      11. WHERE? (physical) stress → WHAT? Too high → WHY? Negative affect, conflicting life goals, generic psychological barriers and/or socio-demographic barriers

12. WHERE? Cholesterol → WHAT? Saturated fat consumption too high → WHY? Eating problem, negative affect, conflicting life goals, generic psychological barriers and/or socio-demographic barriers
13. WHERE? Other risk factors present → WHAT? Hypertension → WHY?
14. WHERE? Other risk factors present → WHAT? specific diabetes complications → WHY?

b. Registration of problem identification into POWER2DM

### 3) Shared decision making about treatment goals

- a. Caregiver and patient agree upon treatment plan with ultimate, mid/long-term goals (based on medical needs and patient values ) with the help of MT2D-MARVEL and Risk engines (BCT – prompt intention formation & prompt specific goal setting).
- b. Caregiver puts ultimate + mid- + long-term goals into POWER2DM
  - i. Ultimate goal is optimisation of HbA1c and DM-QOL.
  - ii. Mid-/long-term goals (WHERE?) are optimisation of insulin/medication, carbohydrates, glucose monitoring, exercise, stress, weight and/or cholesterol.

Examples:

1. Improve insulin/medication adherence
2. Reducing/counting carbohydrates
3. Monitor blood glucose regularly
4. Increasing exercise
5. Reducing stress
6. Reducing weight
7. Reducing cholesterol
8. Reduce blood pressure
9. Reduce specific diabetes complications

c. Caregiver and patient agree upon solution for barriers (WHY?). Example:

- i. Barrier → Patient regularly forgets blood glucose monitoring. Solution → Patient will set telephone alarm at agreed times right before monitoring.

d. Registration of barriers and solutions to that into POWER2DM

### 4) Shared decision making about treatment plans

- a. Caregiver and patient agree upon short-term goals (i.e., reduce (specific/general) psychological barriers; WHY?) with committed action plans with the help of KADIS to reach the mid-/long-term goals (BCT – prompt specific goal setting and action planning).

Examples:

- i. Ultimate goal: optimizing DM-QOL by reducing hindrance of hyper- and hypoglycaemia daily  
Mid-/long-term goal: making blood glucose monitoring a daily habit within the next 6 months by determining and keeping set times at which monitoring occurs  
Short-term goal: increase blood glucose measurements from 1 to 4 times daily when wake up, before lunch, before dinner, before going to bed within the next month  
Barrier: regularly forgetting to monitor blood glucose  
Action plans: set alarm in smartphone at fixed times (wake up, before lunch, before dinner, before going to bed), preparing a bag with monitoring equipment, bringing monitoring bag everywhere (home, work, when with friends).
- ii. Ultimate goal: optimizing HbA1c by increasing strenuous physical activity  
Mid-/long-term goal: making strenuous physical activity 3 times a week for 30 minutes per time a habit within the next 6 months by means of running, and increase activity from one day of 30 minutes strenuous physical activity per week, to 3 days per week of 30 minutes strenuous physical activity in the next 3 months  
Short-term goal: increase running 3 km in 25 minutes to 5 km in 30 minutes on Monday-Wednesday-Friday while my partner is putting the kids to bed in the next month  
Barriers: no time for running because of young children, no support from partner

Action plans: ask partner to put the kids to bed at Monday-Wednesday-Friday, download run schema at My Asics to run 5 km in 30 minutes within the next month, buy new running clothes.

- b. Registration of short-term goals + committed action plans into POWER2DM
- c. Registration of patient-specific boundaries of the POWER2DM system by caregiver into POWER2DM (when should the caregiver be warned by POWER2DM)

## 4.2.2 Self-management phase

### 5) Monitoring and self-management

- a. POWER2DM checks whether the patients' personal values are clear
  - i. If no → POWER2DM value compass (APE = action plan engine)
  - ii. If yes → b
- b. POWER2DM checks with the patient whether action plans are feasible, specific and motivating
  - i. If no → POWER2DM further specifies action plans into feasible plans (BCT – action planning), increases intrinsic motivation with help of barrier analysis system (APE; BCT – motivational interviewing & prompt focus on past successes)
  - ii. If yes → see c
- c. Patient attempts to achieve these action plans
- d. Patient monitors successes and failures with the help of POWER2DM (BCT – Prompt review of behavioral goals & prompt self-monitoring of behavior)
  - i. POWER2DM reminds patient of action plans and their relation to personal values via SMS/text messages
  - ii. POWER2DM checks success dynamically (just-in-time; right after actions were planned) or within 2 weeks after the plans were made;
  - iii. Successful → POWER2DM rewards/reinforces the patients successes and facilitate continuation, successes are stored into POWER2DM (BCT – provide feedback on performance & provide contingent rewards)
  - iv. NOT successful
    - 1. POWER2DM identifies successes and type of barriers (BCT – prompt focus on past successes + prompt barrier identification). Examples: did or did not think about checking blood glucose, did or did not forget, had or had no time, can or cannot be honest with their partner about diabetes care, plan was not specific enough, treatment goal was not feasible, patient wants to change personal values;
    - 2. POWER2DM suggests adjusted plans (BCT – prompt barrier identification & action planning). Examples: Talk with partner, having small communication training modules to help learn how to talk about issues.
    - 3. Patient chooses plan that suits their situation + teach to use prompts/cues (BCT – Teach to use prompts/cues). Example: Completing communication modules, check glucose in the morning with partner present.
    - 4. POWER2DM stimulates coping planning (identify difficult situation and solutions to that, e.g., by means of if-then sheets; BCT – barrier identification / problem solving )
    - 5. Loop to step 5 (monitoring and self-management) until success is reached (BCT – prompt self-monitoring)
    - 6. Successes and failures are stored into POWER2DM SMSS to adapt future suggested plans + mailed to care giver
- e. Patient makes appointment with care giver in case of complaints (loop to step 1)
- f. POWER2DM warns the caregiver when the patient exceeds diabetes thresholds

**6) Evaluation and feedback**

- a. Patient returns to the caregiver for quarterly/annual check-up (loop to step 1)
- b. Evaluate successes and failures
  - i. Successes and failures are stored into POWER2DM SMSS

## 5 POWER2DM TO-BE SCENARIO – PETER

A general scenario is described in Chapter 5.1. in which persona Peter (Chapter 3.3) follows the TO-BE scenario (Chapter 4.2). In Chapter 5.2. a step-by-step version of the scenario is presented in which parts of the Peter-scenario is explicitly linked to the technical applications of the POWER2DM system (Chapter 2.1) and the general use cases (Chapter 2.2).

### 5.1 Description Peter scenario

#### 5.1.1 Shared decision making phase

##### Before consultation

Peter wants to visit his internist for his quarterly checkup at the hospital. He has been diagnosed with Type 1 DM since he was 19 years. Thus for 24 years he has been living with Type 1 DM. Quite a long time. Peter and his internist make an appointment. Before this appointment Peter is scheduled for some lab research and is invited to fill out some online questionnaires in the online patient portal.

##### Consultation

##### Consent to use POWER2DM

Prior to starting the consultation, a specialized diabetes nurse asks Peter if he would like to use a new system ‘POWER2DM’ that supports people with diabetes taking care of themselves. The specialized diabetes nurse asks consent at the beginning of the consultation, because the internist wants to use POWER2DM immediately during the consult. The specialized diabetes nurse provides more explanation regarding the kind of support POWER2DM provides, like providing different reminders, counselling to improve management of the disease, and forecasting how glucose levels develop depending on insulin/medication, food and exercise. It is a digital system using a webservice and a smartphone application. Peter is immediately charmed by the idea. Peter always carries his smartphone, and has a tablet, a laptop from his work and a desktop at home. So this new system really fits well in his daily digital routines.

Peter signs the Patient Consent Form and the specialized diabetes nurse creates a new account for Peter. The specialized diabetes nurse reminds Peter that the consent also implies that Peter’s clinical information, lab and questionnaire results are entered into the POWER2DM account. This could be done automatically in selected centers, or by uploading information by a POWER2DM member in other centers, depending on availability and legislation in the different clinical settings. Because Peter will take part in the pilot study of Power2DM, the consent also applies that his data will be used for research purposes. The nurse explains that this means that the data of Peter will be stored anonymously into the research database, and that researchers will not be able to relate data to Peter, but that data of all research patients will be used to indicate effects at a group level. The nurse explains that for Peter, this means that he will be requested to share his data for project purposes under specific rules.

##### Anamnesis (WHERE? & WHAT?)

Lab and questionnaire results are available in the consult.

Peter’s HbA1c (= 56 mmol/mol) and BMI (24) are fine. However, after his internist inquires how Peter is doing, Peter admits that managing his T1DM is getting more and more a burden. He would like to have a normal life, and monitoring his glucose levels and injecting insulin are continuously reminding him that his life is not normal. Therefore, Peter doesn’t follow his care regimen as exactly as he used to. As a consequence, he is more frequently hindered by hypers and hypos, which interfere with important aspects of his life, like his work and relationship. In addition Peter feels guilty that he is not strictly following his T1DM regimen. Overall, he is quite sad how his life is going on the last months. The internist and Peter conclude that there is a problem because Peter views his diabetes regimen as a burden and as a result, he is not sufficiently monitoring his glucose levels and not properly taking his insulin/medication.

The internist registers the results of the anamnesis into POWER2DM.

### **Problem identification (WHY?)**

Peter's main problem is his negative feelings/attitude regarding his T1DM care plan. He is tired of managing his disease and the prospect of always having to take care and never to let go. He feels overwhelmed and stressed by the idea. There is a specific psychological barrier, although Peter is an intelligent and highly educated person and has been dealing with his T1DM for 24 years. So he knows what to do and has the skills to do it, but is overwhelmed at the prospect of life-long care for a chronic condition at the moment. This realization of his life-long burden prohibits him to engage in healthy behavior, although he wants to be healthy. His care plan is a constant reminder of his illness. However, it seems that the burden of his care plan is two-sided. First, it interferes with his daily life because he has to monitor too often. Second, it is a cognitive burden, because he should not forget to monitor. There are no problems related to the broader socio-demographic topics, like social support, employment or family issues.

The Internist registers problem identification into POWER2DM.

### **Shared decision making about treatment goals**

Peter and his internist discuss his negative feelings towards his T1DM care regimen. Peter tells that he is really tired of taking care of his disease. His internist points out that Peter says he wants a normal life, but by not monitoring his glucose levels he is actually bringing about an abnormal life cause of the resulting hypes and hypos. Peter acknowledges this contradiction, but says he still feels abnormal because of the continuous monitoring. The internist refers Peter to the medical psychologist of the diabetes team to further discuss his sad feelings about the continuous burden of T2DM.

The internist and Peter do agree on the ultimate goal to reduce the burden of hyper- and hypoglycaemia in his life by adjusting his glucose monitoring and insulin injects so that it better fits his daily life, and on the long term goals making blood glucose monitoring a habit before sports, meetings and family events within the next 3 months and carrying quick carbs daily. They hope this will result in less hindrance of hypes and hypos in sports, work, family and social activities. With the help of MT2D-MARVEL and Risk engines, POWER2DM facilitates the goal setting process; it shows the contradiction between the current and planned situation and the long-term benefits for Peter of the plans made.

The internist puts ultimate + mid- + long-term goals into POWER2DM.

### **Shared decision making about treatment plans**

Peter and his internist decide that for diminishing the negative effects of hypos Peter should carry quick carbs all the time, so he can take them when a hypo starts. Peter will decide at home which quick carbs suits him best. Peter is an experienced diabetes patient and recognizes the start of a hypo pretty correctly, but POWER2DM may provide additional warnings. KADIS enables the prediction of a hypo and a warning can be sent to Peter's smartphone at the time when the glucose level is predicted as being too low.

In order to reduce the extent of monitoring and also the reminder of his disease, they decide that monitoring glucose levels is especially important before sports, meetings with friends and family events. They decide that Peter allows POWER2DM to connect to his digital agenda so reminders can be sent to his smartphone before social and sport meetings. He will be reminded of preparing and bringing a bag with monitoring equipment to these events (Behavior Change Techniques = BCT: prompt specific goal setting and action planning). In order to form habits, POWER2DM will send Peter a compliment on his smartphone when he completes a check (BCT: Provide contingent rewards).

Peter and the internist agree upon short-term goals (i.e., reduce (specific/general) psychological barriers; WHY?) with committed action plans to reach the mid-/long-term goals.

Internist registers short-term goals + committed action plans into POWER2DM

Internist registers that POWER2DM should warn Peter when glucose levels exceed XXX.

(OPTIONAL) If KADIS is recommended, specify action plan (introduction and education regarding KADIS, instructions for baseline data collection phase; CGM usage, logging calorie intakes, physical activities, Metabolic Fingerprint, etc) for baseline data collection.

### **Summary Treatment Goals and Plans**

Ultimate goal: reduce the burden of hyper- and hypoglycaemia in his life by adjusting his glucose monitoring + by adjusting insulin injections so that it fits his daily life

Mid-/long-term goal: within the next 3 months making blood glucose monitoring a habit before important daily life + improve insulin injections

Short-term goal: within the next month, monitor blood glucose measurements before going to sports, meetings with his friends from the university and family events + carrying quick carbs daily.

Barrier: feeling sad, forgetting to monitor his glucose level in case of meetings with friends from the university

Action plans:

1. send warnings at specific time that KADIS predicts too low glucose level
2. set reminder in smartphone before social and sport meeting through digital agenda
3. decide which carbs suits him best to carry daily
4. preparing a bag with monitoring equipment + quick carbs
5. bringing monitoring bag to sports, meetings with friends and family events.

## **5.1.2 Self-Management phase**

### **Week 1**

Peter is interested to use POWER2DM and starts the web-service at his laptop Saturday morning after his visit to the internist. POWER2DM offers Peter a visual tour of the system, because this is his first visit. Peter accepts and gets acquainted with the various functions of POWER2DM. In the tour Peter is invited to personalize his account. He can upload a photo, connect his digital agenda with POWER2DM, set ringtones and timezone and choose an avatar who will guide him through the system and can be asked for help. He also wants to receive news about POWER2DM and Diabetes once a week through his email account which he enters in the system.

POWER2DM also inquires if Peter uses certain glucose monitors by providing a list of possible monitors. Peter selects his device. POWER2DM offers to log his data directly from his monitor into the online log-book of Power2DM. Peter agrees and goes through the steps to link his monitor to POWER2DM. This check is also done for other measures/wearables.

In the next step of the tour POWER2DM asks for other specific apps or wearables that may provide useful information for the management of his Diabetes. Peter realizes that his Fitbit data can be uploaded to POWER2DM. Peter follows the instructions how to connect his Fitbit to POWER2DM. Peter is pleased that also other medical devices like blood pressure monitors or pulsioxymeters may interact with POWER2DM, although he is not using those devices at the time. He also uses the app “mySugr Diabetes Logbook”, but to his disappointment it is not possible to link this app with POWER2DM. However, POWER2DM tells him that POWER2DM provides its own logbook.

During the tour he is also asked about privacy and security settings. Peter has to indicate which health professionals take care of his diabetes and who are allowed access to his personal data. He allows his internist and his specialized Diabetes nurse to access his data. POWER2DM also asks if other people, like a partner, child, parent or friend may have access. Peter decides that the care of his Diabetes is his own responsibility and does not allow private persons to access his data. He also does not want links with his Twitter or Facebook account. He indicates that he wants to be warned if someone tries to access his data, who he did not approve of.

### **Value Compass**

The psychologist also explained Peter that for a successful execution of the treatment plan, the treatment goals have to agree with his goals and values in life. Personal life goals and values describe what is most important, satisfying and enjoyable in a person’s life. Like a compass they can guide a person in the direction that he most wants to go in his life. As Peter wants to have a life full of vitality despite diabetes, he decides to use the “Value Compass” of the Action Plan Engine in order to become more aware of his personal values and to specify them. POWER2DM guides Peter with questions through the Value Compass. Peter realizes that currently two of his personal values are impaired by his diabetes:

- He *enjoys running* but because of his fear of hypos he nearly stopped his favorite sport. That is something Peter already discussed with his doctor. Being aware that jogging is really a pleasure to him, he is willing to monitor his blood glucose more strictly to avoid hypos and being able again to enjoy jogging without fear.
- Another personal value was *painting comics and pictures such as still lifes*. He knows that he needs good eyes and calm hands for this hobby. He realizes that if he wants to carry on with his hobby in later age, he has to manage his diabetes properly.

After finishing the value check, POWER2DM advises Peter to take the next step to specify the way he wants to manage his diabetes as discussed with his internist.

### **Self-management Goals and Activities (Action Plan Engine)**

Power2DM shows Peter his self-management goals and plans. Power2DM asks Peter whether these are feasible, and whether he is capable and willing to achieve it. Peter agrees that he is capable and willing to achieve the self-management goals, but they are not feasible. Power2DM asks why they are not feasible enough and Peter indicates that the self-management goals and plans are not specific enough yet. Power2DM provides Peter the opportunity to renew his self-management goals and plans. Based on the treatment goals and on his personal values Peter specifies the following self-management goals:

- within the next month, monitor blood glucose measurements before going to sports, meetings with his friends from the university and family events
- carrying quick carbs daily
- blood glucose monitoring 4 times per day; if Peter meets this goal for the next 6 months he wants to register to one of these expensive, but excellent painting workshops of his favorite artist
- Jogging at least 2 times per week

In the next step Peter breaks down his self-management goals into short-term activities. He uses the calendar in POWER2DM and specifies the following activities:

- Monitor blood glucose at 7:00, 12:00, 18:00 and 21:00, daily and as a repeating activity; Peter activates a reminder for the next 2 weeks, because after 2 weeks he should be used to this activity and assumes that he needs no more reminder for this activity
- Jogging on Wednesday and Friday, 18:30, reminder for the monitoring bag and quick carbs

### **Specification of Treatment plan Quick carbs**

Power2DM shows Peter his treatment plan to carry quick carbs. By answering POWER2DM's questions he realizes that his plan is not specific enough. The education module of POWER2DM offers Peter an explanation regarding quick carbs and a list to choose from (e.g., Smarties, honey, dextrose tablets). He decides to carry dextrose tablets because they are small and won't melt like Smarties. To get started with carrying dextrose tablets he first has to buy them. He specifies when and where he will buy the tablets in his digital agenda (Buying dextrose tablets and preparing a bag with monitoring equipment and quick carbs, scheduled for Monday 17:00). He agrees that POWER2DM sends him a reminder an hour before that time (JITAI). Peter also agrees that POWER2DM sends him reminders to check if he has still enough tablets. Peter also consents that POWER2DM will invite him to review his action plan by email every week.

A special feature of POWER2DM are the prediction services. The internist told him that using this service would improve his control over hypos. He would be better able to recognize a hypo in time and take quick carbs to prevent the negative effects. So, when Peter finishes specifying the 'quick carbs' action plan, POWER2DM invites him for an educational module how to use the short-term prediction service KADIS. Peter learns which data to enter and how. Also the feedback graphics are explained. To his pleasant surprise he learns that the Fitbit data can be used for KADIS, estimating the amount of exercise, and also the data of his glucose monitor. However, he still has to enter his food intake and insulin injects. He learns that he has to use KADIS 3 consecutive days so the system can determine his personal fingerprint. A part of this calibration phase is that thresholds for hypers and hypos need to be set in collaboration with the specialized diabetes nurse. These thresholds are used to

send warnings to Peter. Another important aspect is that Peter learns to use KADIS in these 3 days. When the KADIS system is calibrated to Peter's diabetes, Peter can activate a module that will warn him that a hypo is due in 15 minutes so that Peter has time to take his quick carbs.

Peter decides that planning his 'quick carb', jogging and glucose monitoring activities and learning to use KADIS is sufficient for now. He will go through the treatment plan for "blood glucose monitoring for special events" on a later time. POWER2DM asks him to set a date when he wants to start with this latter treatment plan, so that the system can remind him.

During the next week Peter executes his Action Plan and records data about his activities with his glucose monitor devices and his smartphone.

### **Month 1 (wks 2-4)**

Peter has bought his dextrose tablets at the supermarket and now he always carries them. He did not even need the reminder to buy the tablets, because he had already bought the tablets when he was reminded. He had some spare time and had bought the tablets, without changing the reminder in his digital agenda. When he was reminded he felt good that he already had bought them. When POWER2DM asked if he succeeded in buying the tablets in the weekly review he could answer affirmatively. POWER2DM displays a motivational message (BCT – provide feedback on performance).

Using KADIS was a different story. The link between his glucose monitor and KADIS did not work very well, so he had to enter the glucose data by hand quite often. In addition, entering all these data was quite challenging and reminding him daily that his life was not an ordinary one. After 2 days he was really fed up with the whole system and was entering imaginary data. His specialized diabetes nurse was warned by POWER2DM that really strange data were entered into KADIS. The nurse called Peter to inquire how things were going on. Peter told her about his frustration with the KADIS system. The nurse understood and suggested him to get a different glucose monitor that would better link with KADIS. The nurse arranged that Peter got a different monitor. She advised him to take a break and restart using KADIS after a week. The nurse entered a reminder for Peter in POWER2DM that he would start using KADIS again.

Peter starts using KADIS again and this time the glucose monitor works very well. He does not have to enter the glucose data by hand anymore. What is still tiresome is entering the food intake. It takes quite some time and therefore he fills in the food intake only in the evening. Then he usually forgets a few things he has eaten during the day. POWER2DM warns him that without timely registrations of his food intake KADIS cannot predict. At the weekly review of action plans in POWER2DM Peter admits that using KADIS is not going very well because of the food intake registrations. POWER2DM refers Peter to the barriers analysis of the Action Plan Engine. By guiding questions he is able to locate specific barriers. It seems that entering the food intake is a very boring activity that is easily forgotten. POWER2DM suggests possible coping strategies how to cope with his barrier. (BCT – barrier identification / problem solving).

Peter tries for a third time to use KADIS properly and now it goes well. To motivate Peter to use KADIS the gaming version is activated by the specialist nurse. Peter is randomly coupled to another novice KADIS user and they compete who is the best in entering the food intake. Peter likes the competition-aspect of entering the food intake. He really wants to beat this other POWER2DM user. He soon masters the super-expert level and gets very well in the table charts. The real benefit is that KADIS now gets correct data to predict hypes and hypos. At the end of the first month Peter receives a warning from KADIS that he needs to take quick carbs. Peter is so surprised that he does not believe it. He does not act on this warning. Unfortunately KADIS was right and Peter experiences the start of a hypo, before he takes his quick carbs. Peter realizes the benefits of KADIS' warning and next time he will take it seriously.

### **Month 2-4**

Peter receives the reminder from POWER2DM to start with his second treatment plan "blood glucose monitoring for special events". The Goal and Plan check shows that the plan needs more specification

before executing it. First, the focus will be on the soccer events. Peter trains once a week on Thursday and has a match on Sunday. The training is a fixed time once a week (8.00-9.30 PM), but the matches differ in time on Sunday. Peter activates reminders for his soccer dates to be send to his smartphone. He will be reminded of preparing and bringing a bag with monitoring equipment to these events. First, he has to prepare this bag and place it next to his soccer gear. Next, he needs to make a detailed action and coping plan. For instance, Peter has to check his glucose level 30 minutes before the game to decide to take extra carbs or an insulin inject. He has to decide where he can do that privately, because he does not want other people to watch him. So, he decides that he does that at home, just before he leaves. POWER2DM action planning engine assists Peter in specifying his actions, by asking questions that Peter have to fill in and POWER2DM can provide some suggestions. In doing so, Peter comes up with a plan in case the soccer match is outbound. In that case he will check his glucose level in his car. The whole action plan is broken down in a chronological order what Peter has to do to execute this plan. POWER2DM suggests that Peter asks a soccer friend to help him execute this plan, because it is quite an elaborated plan. This friend will also provide social support. Peter first does not like this suggestion, because he wants to be treated as a normal person by his friends, but he acknowledges that the help of his friend would be very supporting. Peter and his friend Whatsapp each other before a match and his friend helps him before and after the game with monitoring his glucose levels and balancing his food intake, soccer exercise and insulin shots. POWER2DM checks whether Peter perceives this plan to be feasible and Peter agrees.

POWER2DM suggest that Peter can use KADIS to get a clearer picture of balancing food intake, exercise, and insulin injects to retain at a stable glucose level during soccer training and matches. Peter agrees, because he is already experienced in using KADIS. He clearly recognizes the benefits.

The first 2 or 3 weeks it is quite a conscious processing of the steps that need to be taken to execute the plan. Getting the bag, checking if everything is in the bag. Check glucose level 30 minutes before the game and after the game. Also other back-up plans are thought off, given unexpected barriers that happened, like a parking area quite far away from the soccer field. For Peter it is great that his friend helps him with thinking of new solutions how to deal with new barriers. Also the emotional support is appreciated. Using KADIS clarifies what the best combination of food intake and insulin injects is during the soccer training and matches. KADIS shows the effects of food intake and exercise hours before the game.

After 3 to 4 weeks monitoring glucose levels during soccer becomes habitual. Peter does not have to think about what to take in his bag, also balancing everything to prevent hypos or hypers during the training and game goes very well. Only last time when he had a cold, things needed a closer monitoring.

All in all he feels much more normal now he manages his diabetes much better, so that he hardly has hypos or hypers anymore.

### **5.1.3 Evaluation and Feedback**

Peter returns to the internist for his quarterly check-up. His internist is already informed by the POWER2DM reports that Peter is doing fine at the moment. Peter and the internist evaluate the successes and failures in past 4 months. Also using POWER2DM is evaluated. Peter's HbA1c is fine and also his quality of life is improved. There is no problem to be analyzed. Peter and the internist decide that Peter can continue with the same treatment goals and plans in the next 4 months.

## **5.2 Step-by-step description Peter**

In the step-by-step scenario we use three classifications for the technical applications of the Power2DM system:

1. Not applicable: the scenario step is beyond the scope of POWER2DM.
2. Desirable: a nice to have application in POWER2DM
3. Essential: essential application in POWER2DM in order to fulfill the SMSS and DSS requirements

We also added the general Use Case (Chapter 2.3) to which the scenario step refers.

Scenario step	POWER2DM System & UseCase
<b>Shared decision making phase: Patient and Physician</b>	
<p><b>Before consultation</b> Peter wants to visit his internist for his quarterly checkup at the hospital. He has been diagnosed with Type 1 DM since he was 19 years. Thus for 24 years he has been living with Type 1 DM. Quite a long time. Peter and his internist make an appointment.</p>	Not applicable
<p>Before this appointment Peter is scheduled for some lab research and is invited to fill out some online questionnaires in the online patient portal.</p>	Not Applicable
<b>Consultation</b>	
<p><b>Consent to use POWER2DM</b> Before starting the consultation, a specialized diabetes nurse asks Peter if he would like to use a new system 'POWER2DM' that supports people with diabetes taking care of themselves. The specialized diabetes nurse asks consent at the beginning of the consultation, because the internist wants to use POWER2DM immediately during the consult. The specialized diabetes nurse provides more explanation regarding the kind of support POWER2DM provides, like providing different reminders, counselling to improve management of the disease, and forecasting how glucose levels develop depending on insulin/medication, food and exercise. It is a digital system using a webservice and a smartphone application. Peter is immediately charmed by the idea. Peter always carries his smartphone, and has a tablet, a laptop from his work and a desktop at home. So this new system really fits well in his daily digital routines.</p>	Not applicable
<p>Peter signs the Patient Consent Form and the specialized diabetes nurse creates a new account for Peter.</p>	Essential: <ul style="list-style-type: none"> <li>- POWER2DM User Management, Authentication and Authorization Framework</li> </ul>
<p>The specialized diabetes nurse reminds Peter that the consent also implies that Peter's clinical information, lab and questionnaire results are entered into the POWER2DM account. This could be done automatically in selected centers, or by uploading information by a POWER2DM member in other centers, depending on availability and legislation in the different clinical settings.</p>	Essential: <ul style="list-style-type: none"> <li>- POWER2DM User Management, Authentication and Authorization Framework</li> <li>- Personal data store</li> </ul> UC1
<p>Because Peter will take part in the pilot study of Power2DM, the consent also applies that his data will be used for research purposes. The nurse explains that this means that the data of Peter will be stored anonymously into the research database, and that researchers will not be able to relate data to Peter, but that data of all research patients will be used to indicate effects at a group level. The nurse explains that for Peter, this means that he will be requested to share his data for project purposes under specific rules.</p>	<ul style="list-style-type: none"> <li>- Not Applicable</li> </ul>
<p><b>Anamnesis (WHERE? &amp; WHAT?)</b> Lab and questionnaire results are available in the consult. Peter's HbA1c (= 56 mmol/mol) and BMI (24) are fine. However, after his internist inquires how Peter is doing, Peter admits that managing his T1DM is getting more and more a burden. He would like to have a normal life, and monitoring his glucose levels and injecting insulin are constant reminders that he is not normal. Therefore, Peter doesn't follow his care regimen as exactly as he used to. As a consequence, he is more frequently hindered by hypers and hypos, which interfere with important aspects of his life, like his work and relationship. In</p>	Desirable: <ul style="list-style-type: none"> <li>- Shared decision Making Application</li> <li>- Personal data store</li> </ul>

Scenario step	POWER2DM System & UseCase
<p>addition Peter feels guilty that he is not strictly following his T1DM regimen. Overall, he is quite sad how his life is going on the last months. The internist and Peter conclude that there is a problem because Peter views his diabetes regimen as a burden and as a result, he is not sufficiently monitoring his glucose levels and not properly taking his insulin/medication.</p>	
<p>The internist registers the results of the anamnesis into POWER2DM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> <p>UC1</p>
<p><b>Problem identification (WHY?)</b> Peter's main problem is his negative feelings/attitude regarding his T1DM care plan. He is tired of managing his disease and the prospect of always having to take care and never to let go. He feels overwhelmed and stressed by the idea. There is a specific psychological barrier, although Peter is an intelligent and highly educated person and has been dealing with his T1DM for 24 years. So he knows what to do and has the skills to do it, but is overwhelmed at the prospect of life-long care for a chronic condition at the moment. This realization of his life-long burden prohibits him to engage in healthy behavior, although he wants to be healthy. His care plan is a constant reminder of his illness. However, it seems that the burden of his care plan is two-sided. First, it interferes with his daily life because he has to monitor too often. Second, it is a cognitive burden, because he should not forget to monitor. There are no problems related to the broader socio-demographic topics, like social support, employment or family issues.</p>	<p>Not applicable</p>
<p>The Internist registers problem identification into POWER2DM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> <p>UC2</p>
<p><b>Shared decision making about treatment goals</b> Peter and his internist discuss his negative feelings towards his T1DM care regimen. Peter tells that he is really tired of taking care of his disease. His internist points out that Peter says he wants a normal life, but by not monitoring his glucose levels he is actually bringing about an abnormal life cause of the resulting hypers and hypos.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Prediction services (KADIS)</li> </ul> <p>UC3</p>
<p>Peter acknowledges this contradiction, but says he still feels abnormal because of the continuous monitoring. The internist refers Peter to the medical psychologist of the diabetes team to further discuss his sad feelings about the continuous burden of T2DM.</p>	<p>Not applicable</p>
<p>The internist and Peter do agree on the <u>ultimate goal</u> to reduce the burden of hyper- and hypoglycaemia in his life by adjusting his glucose monitoring and insulin injects so that it better fits his daily life, and on the <u>long term goals</u> making blood glucose monitoring a habit before sports, meetings and family events within the next 3 months and carrying quick carbs daily. They hope this will result in less hindrance of hypers and hypos in sports, work, family and social activities. With the help of MT2D-MARVEL and Risk engines, POWER2DM facilitates the goal setting process; it shows the contradiction between the current and planned situation and the long-term benefits for Peter of the plans made.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Prediction services (MT2D-Marvel, Risk engines)</li> </ul> <p>UC4</p>
<p>The internist puts ultimate + mid- + long-term goals into POWER2DM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> </ul>

Scenario step	POWER2DM System & UseCase
	<ul style="list-style-type: none"> <li>- Personal data store</li> </ul> UC5
The medical psychologist and Peter agree that Peter will follow cognitive behavior therapy to reduce his sad feelings towards dealing with his T1DM.	Not applicable
The medical psychologist registers this barrier and solution into POWER2DM	Essential: <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> UC2, UC5
<b>Shared decision making about treatment plans</b> Peter and his internist decide that for diminishing the negative effects of hypos Peter should carry quick carbs all the time, so he can take them when a hypo starts. Peter will decide at home which quick carbs suits him best. Peter is an experienced diabetes patient and recognizes the start of a hypo pretty correctly, but POWER2DM may provide additional warnings. KADIS enables the prediction of a hypo and a warning can be sent to Peter's smartphone at the time when the glucose level is predicted as being too low.	Not applicable
In order to reduce the extent of monitoring and also the reminder of his disease, they decide that monitoring glucose levels is especially important before sports, meetings with friends and family events. They decide that Peter allows POWER2DM to connect to his digital agenda so reminders can be sent to his smartphone before social and sport meetings. He will be reminded of preparing and bringing a bag with monitoring equipment to these events (Behavior Change Techniques = BCT: prompt specific goal setting and action planning). In order to form habits, POWER2DM will send Peter a compliment on his smartphone when he completes a check (BCT: Provide contingent rewards). Peter and the internist agree upon <u>short-term goals</u> (i.e., reduce (specific/general) psychological barriers; WHY?) with committed action plans to reach the <u>mid-/long-term goals</u> .	Not applicable
Internist registers short-term goals + committed action plans into POWER2DM Internist registers that POWER2DM should warn Peter when glucose levels exceed XXX.	Essential: <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> UC5
(OPTIONAL) If KADIS is recommended, specify action plan (introduction and education regarding KADIS, instructions for baseline data collection phase; CGM usage, logging calorie intakes, physical activities, Metabolic Fingerprint, etc) for baseline data collection.	Optional: <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> UC5
<b>Summary Treatment Goals and Plans</b> <u>Ultimate goal</u> : reduce the burden of hyper- and hypoglycaemia in his life by adjusting his glucose monitoring + by adjusting insulin injections so that it fits his daily life <u>Mid-/long-term goal</u> : within the next 3 months making blood glucose monitoring a habit before important daily life + improve insulin injections <u>Short-term goal</u> : within the next month, monitor blood glucose measurements before going to sports, meetings with his friends from the university and family events + carrying quick carbs daily. <u>Barrier</u> : feeling sad, forgetting to monitor his glucose level in case of meetings with friends from the university <u>Action plans</u> :	Not applicable (was already registered, see before)

Scenario step	POWER2DM System & UseCase
<ol style="list-style-type: none"> <li>1. send warnings at specific time that KADIS predicts too low glucose level</li> <li>2. set reminder in smartphone before social and sport meeting through digital agenda</li> <li>3. decide which carbs suits him best to carry daily</li> <li>4. preparing a bag with monitoring equipment + quick carbs</li> <li>5. bringing monitoring bag to sports, meetings with friends and family events.</li> </ol>	
<p><b>Self-Management phase: Patient</b></p>	
<p><b>Week 1</b> Peter is interested to use POWER2DM and starts the web-service at his laptop Saturday morning after his visit to the internist. POWER2DM offers Peter a visual tour of the system, because this is his first visit. Peter accepts and gets acquainted with the various functions of POWER2DM.</p>	<p>Desirable</p> <ul style="list-style-type: none"> <li>- POWER2DM User Management, Authentication and Authorization Framework</li> </ul>
<p>In the tour Peter is invited to personalize his account. He can upload a photo, connect his digital agenda with POWER2DM, set ringtones and timezone and choose an avatar who will guide him through the system and can be asked for help. He also wants to receive news about POWER2DM and Diabetes once a week through his email account which he enters in the system. POWER2DM also inquires if Peter uses certain glucose monitors by providing a list of possible monitors. Peter selects his device. POWER2DM offers to log his data directly from his monitor into the online log-book of Power2DM. Peter agrees and goes through the steps to link his monitor to POWER2DM. This check is also done for other measures/wearables.</p> <p>In the next step of the tour POWER2DM asks for other specific apps or wearables that may provide useful information for the management of his Diabetes. Peter realizes that his Fitbit data can be uploaded to POWER2DM. Peter follows the instructions how to connect his Fitbit to POWER2DM. Peter is pleased that also other medical devices like blood pressure monitors or pulsioxymeters may interact with POWER2DM, although he is not using those devices at the time. He also uses the app “mySugr Diabetes Logbook”, but to his disappointment it is not possible to link this app with POWER2DM. However, POWER2DM tells him that POWER2DM provides its own logbook.</p> <p>During the tour he is also asked about privacy and security settings. Peter has to indicate which health professionals take care of his diabetes and who are allowed access to his personal data. He allows his internist and his specialized Diabetes nurse to access his data. POWER2DM also asks if other people, like a partner, child, parent or friend may have access. Peter decides that the care of his Diabetes is his own responsibility and does not allow private persons to access his data. He also does not want links with his Twitter or Facebook account. He indicates that he wants to be warned if someone tries to access his data, who he did not approve of.</p>	<p>Desirable/essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM User Management, Authentication and Authorization Framework</li> <li>- Personal data store</li> <li>- Recommender engine</li> <li>- POWER2DM mobile application</li> </ul> <p>Essential are:</p> <ul style="list-style-type: none"> <li>- Listing glucose monitor</li> <li>- Listing apps/wearables/medical devices</li> <li>- Allowing access to specific persons (professionals &amp; supporting friends/family)</li> <li>- Tutorial (Tour)</li> </ul> <p>UC8</p> <p>Desirable:</p> <ul style="list-style-type: none"> <li>- Agenda connection</li> <li>- Digital logbook</li> <li>- Links to social media</li> <li>- Avatar</li> </ul>
<p><b>Value Compass</b> The psychologist also explained Peter that for a successful execution of the treatment plan, the treatment goals have to agree with his goals and values in life. Personal life goals and values describe what is most important, satisfying and enjoyable in a person’s life. Like a compass they can guide a</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> <li>- Personal data store</li> </ul> <p>UC6</p>

Scenario step	POWER2DM System & UseCase
<p>person in the direction that he most wants to go in his life. As Peter wants to have a life full of vitality despite diabetes, he decides to use the “Value Compass” of the Action Plan Engine in order to become more aware of his personal values and to specify them. POWER2DM guides Peter with questions through the Value Compass. Peter realizes that currently two of his personal values are impaired by his diabetes:</p> <ul style="list-style-type: none"> <li>• He <i>enjoys running</i> but because of his fear of hypos he nearly stopped his favorite sport. That is something Peter already discussed with his doctor. Being aware that jogging is really a pleasure to him, he is willing to monitor his blood glucose more strictly to avoid hypos and being able again to enjoy jogging without fear.</li> <li>• Another personal value was <i>painting comics and pictures such as still lifes</i>. He knows that he needs good eyes and calm hands for this hobby. He realises that if he wants to carry on with his hobby in later age, he has to manage his diabetes properly.</li> </ul>	
<p>After finishing the value check, POWER2DM advices Peter to take the next step to specify the way he wants to manage his diabetes as discussed with his internist.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> </ul>
<p><b>Self-management Goals and Activities (Action Plan Engine)</b> Power2DM shows Peter his self-management goals and plans. Power2DM asks Peter whether these are feasible, and whether he is capable and willing to achieve it. Peter agrees that he is capable and willing to achieve the self-management goals, but they are not feasible. Power2DM asks why they are not feasible enough and Peter indicates that the self-management goals and plans are not specific enough yet. Power2DM provides Peter the opportunity to renew his self-management goals and plans. Based on the treatment goals and on his personal values Peters specifies the following self-management goals:</p> <ul style="list-style-type: none"> <li>• within the next month, monitor blood glucose measurements before going to sports, meetings with his friends from the university and family events</li> <li>• carrying quick carbs daily</li> <li>• blood glucose monitoring 4 times per day ; if Peter meets this goal for the next 6 months he wants to register to one of these expensive, but excellent painting workshops of his favorite artist</li> <li>• Jogging at least 2 times per week</li> </ul>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> </ul> <p>UC6, UC7</p>
<p>In the next step Peter breaks down his self-management goals into short-term activities. He uses the calendar in POWER2DM and specifies the following activities:</p> <ul style="list-style-type: none"> <li>• Monitor blood glucose at 7:00, 12:00, 18:00 and 21:00, daily and as a repeating activity; Peter activates a reminder for the next 2 weeks, because after 2 weeks he should be used to this activity and assumes that he needs no more reminder for this activity</li> <li>• Jogging on Wednesday and Friday, 18:30, reminder for the monitoring bag and quick carbs</li> </ul>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> </ul> <p>UC6, UC7</p>
<p><b>Specification of Treatment plan Quick carbs</b> Power2DM shows Peter his treatment plan to carry quick carbs. By answering POWER2DM’s questions he realizes that his plan is not specific enough. The education module of POWER2DM offers Peter an explanation regarding quick carbs and a list to choose from (e.g., Smarties, honey, dextrose tablets). He decides to carry dextrose tablets because they are</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> <li>- Action plan engine</li> <li>- Recommender engine</li> </ul> <p>UC7, UC8, UC9</p>

Scenario step	POWER2DM System & UseCase
<p>small and won't melt like Smarties. To get started with carrying dextrose tablets he first has to buy them. He specifies when and where he will buy the tablets in his digital agenda (Buying dextrose tablets and preparing a bag with monitoring equipment and quick carbs, scheduled for Monday 17:00). He agrees that POWER2DM sends him a reminder an hour before that time (JITAI). Peter also agrees that POWER2DM sends him reminders to check if he has still enough tablets. Peter also consents that POWER2DM will invite him to review his action plan by email every week.</p>	<p>Desirable:</p> <ul style="list-style-type: none"> <li>- education module quick carbs</li> </ul>
<p>A special feature of POWER2DM are the prediction services. The internist told him that using this service would improve his control over hypos. He would be better able to recognize a hypo in time and take quick carbs to prevent the negative effects. So, when Peter finishes specifying the 'quick carbs' action plan, POWER2DM invites him for an educational module how to use the short-term prediction service KADIS. Peter learns which data to enter and how. Also the feedback graphics are explained. To his pleasant surprise he learns that the Fitbit data can be used for KADIS, estimating the amount of exercise, and also the data of his glucose monitor. However, he still has to enter his food intake and insulin injects. He learns that he has to use KADIS 3 consecutive days so the system can determine his personal fingerprint. A part of this calibration phase is that thresholds for hypers and hypos need to be set in collaboration with the specialized diabetes nurse. These thresholds are used to send warnings to Peter. Another important aspect is that Peter learns to use KADIS in these 3 days. When the KADIS system is calibrated to Peter's diabetes, Peter can activate a module that will warn him that a hypo is due in 15 minutes so that Peter has time to take his quick carbs.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> <li>- Recommender engine</li> <li>- Prediction service (KADIS)</li> </ul> <p>UC9</p> <p>Desirable:</p> <ul style="list-style-type: none"> <li>- education module KADIS</li> </ul>
<p>Peter decides that planning his 'quick carb', jogging and glucose monitoring activities and learning to use KADIS is sufficient for now. He will go through the treatment plan for "blood glucose monitoring for special events" on a later time. POWER2DM asks him to set a date when he wants to start with this latter treatment plan, so that the system can remind him.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> <li>- Recommender engine</li> </ul>
<p>During the next week Peter executes his Action Plan and records data about his activities with his glucose monitor devices and his smartphone.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> <li>- Recommender engine</li> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> </ul> <p>UC8, UC9</p>
<p><b>Month 1 (wks 2-4)</b> Peter has bought his dextrose tablets at the supermarket and now he always carries them. He did not even need the reminder to buy the tablets, because he had already bought the tablets when he was reminded. He had some spare time and had bought the tablets, without changing the reminder in his digital agenda. When he was reminded he felt good that he already had bought them.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> <li>- Recommender engine</li> </ul> <p>UC9</p>
<p>When POWER2DM asked if he succeeded in buying the tablets in the weekly review he could answer affirmatively. POWER2DM displays a motivational message (BCT – provide feedback on performance).</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> <li>- Action plan engine</li> </ul> <p>UC10</p>
<p>Using KADIS was a different story. The link between his glucose monitor and KADIS did not work very well, so he had</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Personal data store</li> </ul>

Scenario step	POWER2DM System & UseCase
to enter the glucose data by hand quite often. In addition, entering all these data was quite challenging and reminding him daily that his life was not an ordinary one. After 2 days he was really fed up with the whole system and was entering imaginary data.	<ul style="list-style-type: none"> <li>- Action plan engine</li> </ul> UC8
His specialized diabetes nurse was warned by POWER2DM that really strange data were entered into KADIS. The nurse called Peter to inquire how things were going on. Peter told her about his frustration with the KADIS system. The nurse understood and suggested him to get a different glucose monitor that would better link with KADIS. The nurse arranged that Peter got a different monitor. She advised him to take a break and restart using KADIS after a week. The nurse entered a reminder for Peter in POWER2DM that he would start using KADIS again.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Recommender engine</li> </ul> UC9  Desirable: <ul style="list-style-type: none"> <li>- Warning to nurse</li> <li>- Nurse can set reminders</li> </ul>
Peter starts using KADIS again and this time the glucose monitor works very well. He does not have to enter the glucose data by hand anymore. What is still tiresome is entering the food intake. It takes quite some time and therefore he fills in the food intake only in the evening.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Prediction service (KADIS)</li> </ul> UC3
Then he usually forgets a few things he has eaten during the day. POWER2DM warns him that without timely registrations of his food intake KADIS cannot predict.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Recommender engine</li> </ul> UC9
At the weekly review of action plans in POWER2DM Peter admits that using KADIS is not going very well because of the food intake registrations. POWER2DM refers Peter to the barriers analysis of the Action Plan Engine. By guiding questions he is able to locate specific barriers. It seems that entering the food intake is a very boring activity that is easily forgotten. POWER2DM suggests possible coping strategies how to cope with his barrier. (BCT – barrier identification / problem solving).	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Action plan engine</li> </ul> UC6, UC10
Peter tries for a third time to use KADIS properly and now it goes well. To motivate Peter to use KADIS the gaming version is activated by the specialist nurse. Peter is randomly coupled to another novice KADIS user and they compete who is the best in entering the food intake. Peter likes the competition-aspect of entering the food intake. He really wants to beat this other POWER2DM user. He soon masters the super-expert level and gets very well in the table charts. The real benefit is that KADIS now gets correct data to predict hypens and hypos. At the end of the first month Peter receives a warning from KADIS that he needs to take quick carbs. Peter is so surprised that he does not believe it. He does not act on this warning. Unfortunately KADIS was right and Peter experiences the start of a hypo, before he takes his quick carbs. Peter realizes the benefits of KADIS' warning and next time he will take it seriously.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Recommender engine</li> <li>- Prediction service (KADIS)</li> </ul> UC3, UC8,  Desirable: <ul style="list-style-type: none"> <li>- Serious games</li> <li>- Contact with other users</li> </ul>
<b>Month 2-4</b> Peter receives the reminder from POWER2DM to start with his second treatment plan “blood glucose monitoring for special events”.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Recommender engine</li> </ul> UC9
The Goal and Plan check shows that the plan needs more specification before executing it. First, the focus will be on the soccer events. Peter trains once a week on Thursday and has a match on Sunday. The training is a fixed time once a week (8.00-9.30 PM), but the matches differ in time on Sunday. Peter	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Action plan engine</li> </ul> UC7

Scenario step	POWER2DM System & UseCase
activates reminders for his soccer dates to be send to his smartphone.	
He will be reminded of preparing and bringing a bag with monitoring equipment to these events. First, he has to prepare this bag and place it next to his soccer gear. Next, he needs to make a detailed action and coping plan. For instance, Peter has to check his glucose level 30 minutes before the game to decide to take extra carbs or an insulin inject. He has to decide where he can do that privately, because he does not want other people to watch him. So, he decides that he does that at home, just before he leaves. POWER2DM action planning engine assists Peter in specifying his actions, by asking questions that Peter have to fill in and POWER2DM can provide some suggestions. In doing so, Peter comes up with a plan in case the soccer match is outbound. In that case he will check his glucose level in his car. The whole action plan is broken down in a chronological order what Peter has to do to execute this plan. POWER2DM suggests that Peter asks a soccer friend to help him execute this plan, because it is quite an elaborated plan. This friend will also provide social support.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Action plan engine</li> </ul> UC7
Peter first does not like this suggestion, because he wants to be treated as a normal person by his friends, but he acknowledges that the help of his friend would be very supporting. Peter and his friend Whatsapp each other before a match and his friend helps him before and after the game with monitoring his glucose levels and balancing his food intake, soccer exercise and insulin shots. POWER2DM checks whether Peter perceives this plan to be feasible and Peter agrees.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Action plan engine</li> </ul> UC7
POWER2DM suggest that Peter can use KADIS to get a clearer picture of balancing food intake, exercise, and insulin injects to retain at a stable glucose level during soccer training and matches.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Recommender engine</li> </ul> UC9
Peter agrees, because he is already experienced in using KADIS. He clearly recognizes the benefits.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Prediction service (KADIS)</li> </ul> UC3
The first 2 or 3 weeks it is quite a conscious processing of the steps that need to be taken to execute the plan. Getting the bag, checking if everything is in the bag. Check glucose level 30 minutes before the game and after the game.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Mobile Application</li> </ul> UC8
Also other back-up plans are thought off, given unexpected barriers that happened, like a parking area quite far away from the soccer field. For Peter it is great that his friend helps him with thinking of new solutions how to deal with new barriers. Also the emotional support is appreciated. Using KADIS clarifies what the best combination of food intake and insulin injects is during the soccer training and matches. KADIS shows the effects of food intake and exercise hours before the game.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Prediction service (KADIS)</li> <li>- Action plan engine</li> </ul> UC3, UC7
After 3 to 4 weeks monitoring glucose levels during soccer becomes habitual. Peter does not have to think about what to take in his bag, also balancing everything to prevent hypos or hypers during the training and game goes very well. Only last time when he had the cold, things needed a closer monitoring. All in all he feels much more normal now he manages his diabetes much better, so that he hardly has hypos or hypers anymore.	Essential: <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Prediction service (KADIS)</li> </ul> UC3, UC7
<b>Evaluation and Feedback: Patient and</b>	Essential:

<b>Scenario step</b>	<b>POWER2DM System &amp; UseCase</b>
<p><b>physician</b>                      Peter returns to the internist for his quarterly check-up. His internist is already informed by the POWER2DM reports that Peter is doing fine at the moment. Peter and the internist evaluate the successes and failures in past 4 months. Also using POWER2DM is evaluated. Peter's HbA1c is fine and also his quality of life is improved. There is no problem to be analyzed. Peter and the internist decide that Peter can continue with the same treatment goals and plans in the next 4 months.</p>	<ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> UC1, UC2

## 6 POWER2DM TO-BE SCENARIO – ANA

### 6.1 Description Ana scenario

#### 6.1.1 Shared decision making phase

##### **Before consultation**

Ana visits her internist for her quarterly checkup at the hospital. She is a Type 2 DM patient since 12 years; before her appointment she performs her blood analysis. She is not very used to computers and technology, so when her internists gives her instructions to fill out some online questionnaires, she asks her daughter to do it.

##### **Consultation**

###### **Consent to use POWER2DM**

Before the consult, the nurse asks Ana if she would be willing to start a program called POWER2DM devoted to help patients with Diabetes to cope with the disease. Ana is a little reluctant, because she does not feel confident with new experiences, but her daughter accompanying her thinks that it will be a great idea and offers to help. Finally, Ana accepts, and signs the informed consent to enter the program. The nurse, as a part of this consent, informs Ana that part of her information will be securely uploaded to a secure cloud, which Ana accepts. She feels a little overwhelmed with the information given during the explanation because it includes a lot of “challenging” informatics procedures, but her daughter finds it extremely positive because she thinks that it has a lot of potential to increase the control of the disease. She offers to take control of the “programs”, and Ana feels better with the idea. In fact, Ana knows that she is not controlling her disease at all, and loves that there is a way to take away that feeling.

###### **Anamnesis (WHERE? & WHAT?)**

Lab and questionnaire results are available in the consult.

Ana’s HbA1c (= 7,9%) and BMI (34) are out of control. This is a repetitive situation, and the internist does not easily understand that, even after some treatment regimens control, the HbA1c does not improve, and the BMI actually is increasing. The internist asks Ana if she thinks that there may be a problem that is interfering with the treatment. She tells him that she feels insecure about her capacity to take the treatment correctly. Since she is a widow, she lives with her daughter, and does not want to weight her down with more work. Sometimes, when she has to take her pills she is not confident if she already took them, and she is very afraid of hypos, since she had one a year ago, and she had to go to the hospital. As a consequence, she tends to skip some antidiabetic medication here and there. As she is not able to control the Lantus dose, she is not even performing fingerpricks.

Regarding exercise, Ana is sometimes taking care of her grandchildren, and prefers to stay at home for more safety. After all this, the internist and Ana realize that there is a problem because Ana is not confident with her ability to take control of the treatment and is failing to correctly monitor her status and her treatment. This information is entered into POWER2DM.

###### **Problem identification (WHY?)**

The main problem that Ana has is a sensation of inability to cope with the disease. Although she has worked as a teacher during her working life, and she has recently retired, she is not self-confident. The combination of her new widow status and the fear to have a hypo when taking care of the grandchildren makes her to have abandoned the correct control of medication. She knows that she has lost the control of the pill and insulin correct taking, but her fear to have a complication is lower to that of being a charge or suffering a hypo.

There are no problems related to the broader socio-demographic topics, like social support, employment or family issues.

The Internist registers problem identification into POWER2DM.

### **Shared decision making about treatment goals**

After debating all of the above, Ana and the internist try to find a solution for the current situation. Ana's daughter is surprised about her mother's feelings. She has left the care of her children to Ana to fill out the loneliness of her mother, and does not want to make her feel too responsible. She does not think that her mother is a charge at all, and offers to aid as much as needed. Furthermore, she offers to hire a nanny to help during some times, and free Ana of her fear. Ana feels much better now, knowing of the supportive position of her daughter and agrees to begin to increase the control of the disease. The internist and Ana agree on the goal to reduce her cardiovascular risk, by adhering to the medication, regularly checking the glycemia and adjusting the insulin when needed. Regarding exercise, they both agree that she may try to look for a way to increase it.

With the help of MT2D-MARVEL and Risk engines, POWER2DM facilitates the goal setting process, and shows how she may benefit from adhering to the care plan.

The internist puts ultimate + mid- + long-term goals into POWER2DM.

### **Shared decision making about treatment plans**

The correct medication taking is a cornerstone for Ana's care plan. So the internist and her decide to buy a pillbox, and allow POWER2DM to send medication reminders to her via her smartphone. Ana's daughter offers to help in the day by day checking of the pillbox. About exercising, Ana thinks that she may take the children to the school and go back home by walking every day. As the school is ten minutes away from the home, that will be forty minutes walking a day, divided in four walks. Ana's daughter will take this task here and there, so probably the final week exercise will be achievable by Ana.

Ana and the internist agree upon short-term goals (i.e., reduce (specific/general) psychological barriers; WHY?) with committed action plans to reach the mid-/long-term goals.

Internist registers short-term goals + committed action plans into POWER2DM

Internist registers that POWER2DM should warn Ana at medication time, and in the time to bring/take back the grandchildren to/from the school.

### **Summary Treatment Goals and Plans**

Ultimate goal: reduce the cardiovascular risk by adhering to the medication and exercise.

Mid-/long-term goal: within the next 3 months reaching >80% accomplishment of the medication and reducing 0,5% HbA1c as a result. Loose 3 kg in the next 3 months.

Short-term goal: Within the next month, buy a pillbox, learn to use it, and control it weekly with her daughter. Increase the exercise by leaving/taking back the grandchildren at least 2 times a week during the next month.

Barrier: feeling sad, not controlling her medication and doing no exercise.

Action plans:

1. Buying and learning to use a pillbox
2. Set reminders in smartphone at medication time.
3. Start making exercise by leaving/taking back grandchildren to/from school.

## **6.1.2 Self-Management phase**

### **Week 1**

Ana is interested to use POWER2DM and tells her daughter who starts the web-service at her own laptop Saturday morning after their visit to the internist. At the first usage, POWER2DM offers Ana a visual tour of the system. Tailored by her daughter, she accepts and is informed about the various functions of POWER2DM. Her daughter explains every function and solves every doubt that her mother has. In the tour Ana is invited to personalize her account. She can upload a photo, connect her digital agenda with POWER2DM, set ringtones and timezone and choose an avatar who will guide her through the system and can be asked for help. Ana thinks she is too old for this kind of things but she knows this tool can be very useful to improve her health and she has to make an effort trying to understand it. Her daughter is very proud of Ana.

POWER2DM also inquires if Ana uses certain glucose monitors by providing a list of possible monitors. Her daughter selects her device. POWER2DM offers to log her data directly from her monitor into the online log-book of Power2DM. In this way, her daughter can watch the data and the progress of her mother in any computer. Ana agrees and goes through the steps to link her monitor to POWER2DM.

In the next step of the tour POWER2DM asks for other specific apps or wearables that may provide useful information for the management of her Diabetes. Her daughter does not want to complicate the process and she thinks it is better without these devices. Ana is pleased that also other medical devices like blood pressure monitors or pulsioxymeters may interact with POWER2DM, although she is not using those devices at the time.

During the tour she is also asked about privacy and security settings. Ana has to indicate which health professionals take care of her diabetes and who are allowed access to her personal data. She is not very trusted about this but her daughter says her that it is necessary to follow the diabetes control progression. So, Ana allows her internist to access her data. POWER2DM also asks if other people, like a partner, child, parent or friend may have access. Ana, of course, decides that her daughter will be an active part of the care of her diabetes and allows her to access the data. She does not use Twitter or Facebook and skips these questions. She indicates that she wants to be warned if someone tries to access her data, who she did not approve of.

At the end of the tour, POWER2DM strongly advises to use two functions of POWER2DM in order to specify the way she wants to manage her diabetes as discussed with her internist. However Ana's daughter decides to do this tomorrow on Sunday morning because she knows this is new to her mother and she is not used to this kind of technologies. She wants POWER2DM to provide a reminder on her smartphone tomorrow at 10 AM.

The next morning Ana is having the breakfast and she hears a buzz on her phone. In an email her avatar reminds her to take the next steps in POWER2DM.

### **Value Compass**

The nurse also explained Ana to use POWER2DM Value compass as a guide to know the things that Ana gives more importance and act accordingly. As Ana wants to stop being afraid of cardiovascular events and to suffer a hypo when taking care of their granddaughters in the morning, she tells her daughter she wants to use the “Value Compass” of the Action Plan Engine in order to become more aware of her personal values and to specify them. POWER2DM guides Ana with questions through the Value Compass. Ana realizes that currently two of her personal values are impaired by her diabetes:

- She enjoys walking with her grandchildren and she would love taking them to the school and go back home by walking every day but because of her fear of hypos she is not very confident about it. This is something Ana already discussed with her doctor. Being aware that walking with her grandchildren is really a pleasure to her, she is willing to monitor her blood glucose more strictly to avoid hypos and being able to enjoy walking without fear.
- Another personal value was watching TV and often all the family goes to the theater. She knows that she needs good sight for this hobby. She realises that if she wants to carry on with her hobby in later age, she has to manage her diabetes properly and prevent diabetic retinopathy.

After finishing the value check, POWER2DM advices Ana to take the next step to specify the way she wants to manage her diabetes as discussed with her internist.

### **Self-management Goals and Activities (Action Plan Engine)**

Ana and her daughter have a look at the treatment goals and adopt them in the first step as self-management goals. Next, she asks herself how she can realize these goals as part of her daily life and whether she has to modify them. Based on the treatment goals and on her personal values they specify the following self-management goals:

- Within the next month, buy a pillbox, learn to use it, and control it weekly with her daughter.
- Increase the exercise by leaving/taking back the grandchildren at least 2 times a week.

In the next step Ana breaks down her self-management goals into short-term activities. Her daughter is going to set the calendar in POWER2DM and specifies the following activities for her mother:

- Pill review in the pillbox every day at 20:00. Ana sets a reminder 5 minutes before.
- “Grandchildren school” Mondays, Wednesdays and Fridays at 8:30 (leaving) and 13:00 (taking back). Ana specifies reminders 30 minutes before. During the next week Ana and her daughter execute Action Plan and record data about her activities with her smartphone. She is understanding the process more and more and she is improving her ability to manage this tool.

**Month 1 (wks 2-4)**

Ana bought the pillbox, and now she fills daily her ability to take the pills. With the help of POWER2DM reminders, she is improving the accomplishment of the medication, and by week 4 she performs this task alone, without other help. She is becoming confident that she can do this. As this happens, she is more open minded to talk about it with her daughter, and they share the “fails” in achieving a particular day’s treatment.

She also started to bring/take back the grandchildren to school. This is taking a little more effort than she thought because of tiredness and some fear to be carrying them alone.

**Month 2-4**

At second month, Ana is getting her goal of >80% correct treatment with the help of the pillbox and the reminders of treatment. She is looking forward to go to her medical check next month, because she is sure that her blood analysis would be better, and that makes her feel really good.

She has bought new sport shoes, and now does the “grandchildren school” activity daily. She has had no big problem with this task, and now she considers herself able to be in charge. She is waiting for this moment everyday.

With the children activity, she feels she is more agile now. She weighted yesterday and has lost 3 kg since the beginning of the program. She remembers that POWER2DM popped up a video congratulating her 2<sup>nd</sup> kg loose last month, and that she and her daughter laughed at it. In fact, this is a favourite video of one of her grandchildren, and she always asks to see it.

She remembers that the doctor made her an estimation of her cardiovascular risk at the beginning of the program, and she didn’t like what she saw. She is willing to see the new outlook after her life change.

**6.1.3 Evaluation and Feedback**

Ana returns to the internist for her quarterly check-up. Her internist is already informed by the POWER2DM reports that Ana is doing fine at the moment. Ana and the internist evaluate the successes and failures in past 4 months. Also using POWER2DM is evaluated. Ana’s HbA1c is better now and also her quality of life is improved. There is no problem to be analyzed. Ana and the internist decide that she can continue with the same treatment goals and plans in the next 4 months.

**6.2 Step-by-step description Ana**

In the step-by-step scenario we use three classifications for the technical applications of the Power2DM system:

1. Not applicable: the scenario step is beyond the scope of POWER2DM.
2. Desirable: a nice to have application in POWER2DM
3. Essential: essential application in POWER2DM in order to fulfill the SMSS and DSS requirements

We also added the general Use Case (Chapter 2.3) to which the scenario step refers.

Scenario step	POWER2DM System & UseCase
<b>Shared decision making phase: Patient and Physician</b>	
<b>Before consultation</b> Ana visits her internist for her quarterly checkup at the hospital. She is a Type 2 DM patient since 12 years; before her	Not applicable

Scenario step	POWER2DM System & UseCase
<p>appointment she performs her blood analysis. She is not very used to computers and technology, so when her internists gives her instructions to fill out some online questionnaires, she asks her daughter to do it.</p>	
<p><b>Consultation</b></p>	
<p><b>Consent to use POWER2DM</b>            Before the consult, the nurse asks Ana if she would be willing to start a program called POWER2DM devoted to help patients with Diabetes to cope with the disease. Ana is a little reluctant, because she does not feel confident with new experiences, but her daughter accompanying her thinks that it will be a great idea and offers to help.</p>	<p>Not applicable</p>
<p>Finally, Ana accepts, and signs the informed consent to enter the program.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM User Management, Authentication and Authorization Framework</li> </ul>
<p>The nurse, as a part of this consent, informs Ana that part of her information will be securely uploaded to a secure cloud, which Ana accepts. She feels a little overwhelmed with the information given during the explanation because it includes a lot of “challenging” informatics procedures, but her daughter finds it extremely positive because she thinks that it has a lot of potential to increase the control of the disease. She offers to take control of the “programs”, and Ana feels better with the idea. In fact, Ana knows that she is not controlling her disease at all, and loves that there is a way to take away that feeling.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM User Management, Authentication and Authorization Framework</li> <li>- Personal data store</li> </ul> <p>UC1</p>
<p><b>Anamnesis (WHERE? &amp; WHAT?)</b>            Lab and questionnaire results are available in the consult. Ana’s HbA1c (= 7,9%) and BMI (34) are out of control. This is a repetitive situation, and the internist does not easily understand that, even after some treatment regimens control, the HbA1c does not improve, and the BMI actually is increasing. The internist asks Ana if she thinks that there may be a problem that is interfering with the treatment. She tells him that she feels insecure about her capacity to take the treatment correctly. Since she is a widow, she lives with her daughter, and does not want to weight her down with more work. Sometimes, when she has to take her pills she is not confident if she already took them, and she is very afraid of hypos, since she had one a year ago, and she had to go to the hospital. As a consequence, she tends to skip some antidiabetic medication here and there. As she is not able to control the Lantus dose, she is not even performing fingerpricks.            Regarding exercise, Ana is sometimes taking care of her grandchildren, and prefers to stay at home for more safety. After all this, the internist and Ana realize that there is a problem because Ana is not confident with her ability to take control of the treatment and is failing to correctly monitor her status and her treatment.</p>	<p>Desirable:</p> <ul style="list-style-type: none"> <li>- Shared decision Making Application</li> <li>- Personal data store</li> </ul>
<p>This information is entered into POWER2DM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> <p>UC1</p>
<p>The internist registers the results of the anamnesis into POWER2DM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> <p>UC1</p>
<p><b>Problem identification (WHY?)</b></p>	<p>Not applicable</p>

Scenario step	POWER2DM System & UseCase
<p>The main problem that Ana has is a sensation of inability to cope with the disease. Although she has worked as a teacher during her working life, and she has recently retired, she is not self-confident. The combination of her new widow status and the fear to have a hypo when taking care of the grandchildren makes her to have abandoned the correct control of medication. She knows that she has lost the control of the pill and insulin correct taking, but her fear to have a complication is lower to that of being a charge or suffering a hypo.</p> <p>There are no problems related to the broader socio-demographic topics, like social support, employment or family issues.</p>	
<p>The Internist registers problem identification into POWER2DM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> <p>UC2</p>
<p><b>Shared decision making about treatment goals</b></p> <p>After debating all of the above, Ana and the internist try to find a solution for the current situation. Ana's daughter is surprised about her mother's feelings. She has left the care of her children to Ana to fill out the loneliness of her mother, and does not want to make her feel too responsible. She does not think that her mother is a charge at all, and offers to aid as much as needed. Furthermore, she offers to hire a nanny to help during some times, and free Ana of her fear. Ana feels much better now, knowing of the supportive position of her daughter and agrees to begin to increase the control of the disease.</p>	<p>Not applicable</p>
<p>The internist and Ana agree on the goal to reduce her cardiovascular risk, by adhering to the medication, regularly checking the glycemia and adjusting the insulin when needed. Regarding exercise, they both agree that she may try to look for a way to increase it.</p> <p>With the help of MT2D-MARVEL and Risk engines, POWER2DM facilitates the goal setting process, and shows how she may benefit from adhering to the care plan.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Prediction services (MT2D-Marvel, Risk engines)</li> </ul> <p>UC4</p>
<p>The internist puts ultimate + mid- + long-term goals into POWER2DM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> <p>UC5</p>
<p><b>Shared decision making about treatment plans</b></p> <p>The correct medication taking is a cornerstone for Ana's care plan. So the internist and her decide to buy a pillbox, and allow POWER2DM to send medication reminders to her via her smartphone. Ana's daughter offers to help in the day by day checking of the pillbox. About exercising, Ana thinks that she may take the children to the school and go back home by walking every day. As the school is ten minutes away from the home, that will be forty minutes walking a day, divided in four walks. Ana's daughter will take this task here and there, so probably the final week exercise will be achievable by Ana.</p>	<p>Not applicable</p>
<p>Ana and the internist agree upon <u>short-term goals</u> (i.e., reduce (specific/general) psychological barriers; WHY?) with committed action plans to reach the <u>mid-/long-term goals</u>.</p> <p>Internist registers short-term goals + committed action plans into POWER2DM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> <p>UC5</p>
<p>Internist registers that POWER2DM should warn Ana at medication time, and in the time to bring/take back the grandchildren to/from the school.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul>

Scenario step	POWER2DM System & UseCase
	<ul style="list-style-type: none"> <li>- Power2M mobile application</li> <li>- Recommender engine</li> </ul> UC5
<p><b>Summary Treatment Goals and Plans</b></p> <p><u>Ultimate goal</u>: reduce the cardiovascular risk by adhering to the medication and exercise.</p> <p><u>Mid-/long-term goal</u>: within the next 3 months reaching &gt;80% accomplishment of the medication and reducing 0,5% HbA1c as a result. Lose 3 kg in the next 3 months.</p> <p><u>Short-term goal</u>: Within the next month, buy a pillbox, learn to use it, and control it weekly with her daughter. Increase the exercise by leaving/taking back the grandchildren at least 2 times a week during the next month.</p> <p><u>Barrier</u>: feeling sad, not controlling her medication and doing no exercise.</p> <p><u>Action plans</u>:</p> <ol style="list-style-type: none"> <li>1. Buying and learning to use a pillbox</li> <li>2. Set reminders in smartphone at medication time.</li> <li>3. Start making exercise by leaving/taking back grandchildren to/from school.</li> </ol>	Not applicable (was already registered, see before)
<b>Self-Management phase: Patient</b>	
<p><b>Week 1</b></p> <p>Ana is interested to use POWER2DM and tells her daughter who starts the web-service at her own laptop Saturday morning after their visit to the internist. At the first usage, POWER2DM offers Ana a visual tour of the system. Tailored by her daughter, she accepts and gets acquainted with the various functions of POWER2DM.</p>	Desirable <ul style="list-style-type: none"> <li>- POWER2DM User Management, Authentication and Authorization Framework</li> </ul>
<p>Her daughter explains every function and solves every doubt that her mother has. In the tour Ana is invited to personalize her account. She can upload a photo, connect her digital agenda with POWER2DM, set ringtones and timezone and choose an avatar who will guide her through the system and can be asked for help. Ana thinks she is too old for this kind of things but she knows this tool can be very useful to improve her health and she has to make an effort trying to understand it. Her daughter is very proud of Ana.</p> <p>POWER2DM also inquires if Ana uses certain glucose monitors by providing a list of possible monitors. Her daughter selects her device. POWER2DM offers to log her data directly from her monitor into the online log-book of Power2DM. In this way, her daughter can watch the data and the progress of her mother in any computer. Ana agrees and goes through the steps to link her monitor to POWER2DM.</p> <p>In the next step of the tour POWER2DM asks for other specific apps or wearables that may provide useful information for the management of her Diabetes. Her daughter does not want to complicate the process and she thinks it is better without these devices. Ana is pleased that also other medical devices like blood pressure monitors or pulsioxymeters may interact with POWER2DM, although she is not using those devices at the time.</p> <p>During the tour she is also asked about privacy and security settings. Ana has to indicate which health professionals take care of her diabetes and who are allowed access to her personal data. She is not very trusted about this but her daughter says her</p>	Desirable/essential: <ul style="list-style-type: none"> <li>- POWER2DM User Management, Authentication and Authorization Framework</li> <li>- Personal data store</li> <li>- Recommender engine</li> <li>- POWER2DM mobile application</li> </ul> Essential are: <ul style="list-style-type: none"> <li>- Listing glucose monitor</li> <li>- Listing apps/wearables/medical devices</li> <li>- Allowing access to specific persons (professionals &amp; supporting friends/family)</li> <li>- Tutorial (Tour)</li> </ul> UC8 Desirable: <ul style="list-style-type: none"> <li>- Agenda connection</li> <li>- Digital logbook</li> <li>- Links to social media</li> <li>- Avatar</li> </ul>

Scenario step	POWER2DM System & UseCase
<p>that it is necessary to follow the diabetes control progression. So, Ana allows her internist to access her data. POWER2DM also asks if other people, like a partner, child, parent or friend may have access. Ana, of course, decides that her daughter will be an active part of the care of her diabetes and allows her to access the data. She does not use Twitter or Facebook and skips these questions. She indicates that she wants to be warned if someone tries to access her data, who she did not approve of.</p>	
<p>At the end of the tour, POWER2DM strongly advises to use two functions of POWER2DM in order to specify the way she wants to manage her diabetes as discussed with her internist. However Ana's daughter decides to do this tomorrow on Sunday morning because she knows this is new to her mother and she is not used to this kind of technologies. She wants POWER2DM to provide a reminder on her smartphone tomorrow at 10 AM.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Recommender engine</li> <li>- POWER2DM mobile application</li> </ul>
<p>The next morning Ana is having the breakfast and she hears a buzz on her phone. In an email her avatar reminds her to take the next steps in POWER2DM</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM mobile application</li> <li>- Recommender engine</li> </ul> <p>UC9</p> <p>Desirable:</p> <ul style="list-style-type: none"> <li>- Avatar</li> </ul>
<p><b>Value Compass</b> The nurse also explained Ana to use POWER2DM Value compass as a guide to know the things that Ana gives more importance and act accordingly. As Ana wants to stop being afraid of cardiovascular events and to suffer a hypo when taking care of their granddaughters in the morning, she tells her daughter she wants to use the “Value Compass” of the Action Plan Engine in order to become more aware of her personal values and to specify them. POWER2DM guides Ana with questions through the Value Compass. Ana realizes that currently two of her personal values are impaired by her diabetes:</p> <ul style="list-style-type: none"> <li>• She enjoys walking with her grandchildren and she would love taking them to the school and go back home by walking every day but because of her fear of hypos she is not very confident about it. This is something Ana already discussed with her doctor. Being aware that walking with her grandchildren is really a pleasure to her, she is willing to monitor her blood glucose more strictly to avoid hypos and being able to enjoy walking without fear.</li> <li>• Another personal value was watching TV and often all the family goes to the theater. She knows that she needs good sight for this hobby. She realises that if she wants to carry on with her hobby in later age, she has to manage her diabetes properly and prevent diabetic retinopathy.</li> </ul>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> <li>- Personal data store</li> </ul> <p>UC6</p>
<p>After finishing the value check, POWER2DM advices Ana to take the next step to specify the way she wants to manage her diabetes as discussed with her internist.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> </ul>

Scenario step	POWER2DM System & UseCase
<p>Ana and her daughter have a look at the treatment goals and adopt them in the first step as self-management goals. Next, she asks herself how she can realize these goals as part of her daily life and whether she has to modify them. Based on the treatment goals and on her personal values they specify the following self-management goals:</p> <ul style="list-style-type: none"> <li>• Within the next month, buy a pillbox, learn to use it, and control it weekly with her daughter.</li> <li>• Increase the exercise by leaving/taking back the grandchildren at least 2 times a week.</li> </ul>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> </ul> <p>UC6, UC7</p>
<p>In the next step Ana breaks down her self-management goals into short-term activities. Her daughter is going to set the calendar in POWER2DM and specifies the following activities for her mother:</p> <ul style="list-style-type: none"> <li>• Pill review in the pillbox every day at 20:00. Ana sets a reminder 5 minutes before</li> <li>• “Grandchildren school” Mondays, Wednesdays and Fridays at 8:30 (leaving) and 13:00 (taking back). Ana specifies reminders 30 minutes before.</li> </ul>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> </ul> <p>UC6, UC7</p>
<p>During the next week Ana and her daughter execute the Action Plan and record data about her activities with her smartphone. She is understanding the process more and more and she is improving her ability to manage this tool.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Action plan engine</li> <li>- Recommender engine</li> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> </ul> <p>UC8, UC9</p>
<p><b>Month 1 (wks 2-4)</b></p> <p>Ana bought the pillbox, and now she fills daily her ability to take the pills. With the help of POWER2DM reminders, she is improving the accomplishment of the medication, and by week 4 she performs this task alone, without other help. She is becoming confident that she can do this. As this happens, she is more open minded to talk about it with her daughter, and they share the “fails” in achieving a particular day’s treatment. She also started to bring/take back the grandchildren to school. This is taking a little more effort than she thought because of tiredness and some fear to be carrying them alone.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> <li>- Recommender engine</li> <li>- Action plan engine</li> </ul> <p>UC9, UC10</p>
<p><b>Month 2-4</b></p> <p>At second month, Ana is getting her goal of &gt;80% correct treatment with the help of the pillbox and the reminders of treatment. She is looking forward to go to her medical check next month, because she is sure that her blood analysis would be better, and that makes her feel really good. She has bought new sport shoes, and now does the “grandchildren school” activity daily. She has had no big problem with this task, and now she considers herself able to be in charge. She is waiting for this moment everyday.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- POWER2DM mobile application</li> <li>- Personal data store</li> <li>- Recommender engine</li> <li>- Action plan engine</li> </ul> <p>UC8, UC10</p>
<p>With the children activity, she feels she is more agile now. She weighted yesterday and has lost 3 kg since the beginning of the program. She remembers that POWER2DM popped up a video congratulating her 2<sup>nd</sup> kg loose last month, and that she and her daughter laughed at it. In fact, this is a favourite video of one of her grandchildren, and she always asks to see it.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Personal data store</li> <li>- Action plan engine</li> <li>- Recommender engine</li> </ul> <p>UC8, UC9, UC10</p>
<p>She remembers that the doctor made her an estimation of her cardiovascular risk at the beginning of the program, and she didn’t like what she saw. She is willing to see the new outlook after her life change.</p>	<p>Not applicable</p>

Scenario step	POWER2DM System & UseCase
<p><b>Evaluation and Feedback: Patient and physician</b></p> <p>Ana returns to the internist for her quarterly check-up. Her internist is already informed by the POWER2DM reports that Ana is doing fine at the moment. Ana and the internist evaluate the successes and failures in past 4 months. Also using POWER2DM is evaluated. Ana's HbA1c is better now and also her quality of life is improved. There is no problem to be analyzed. Ana and the internist decide that she can continue with the same treatment goals and plans in the next 4 months.</p>	<p>Essential:</p> <ul style="list-style-type: none"> <li>- Shared decision making application</li> <li>- Personal data store</li> </ul> <p>UC1, UC2</p>

## 7 OPEN ISSUES

In this Chapter the open issues are described that need to be resolved in the continuation of the project.

Issue	posted by	to be resolved by
Update Figure D1.1.1 to most recent version of D1.2	TNO	
In 2.1.1. “describe and enter barriers and solutions”: What does this entail? When and how are barriers identified?	LUMC	
In 2.1.2 “Fixed Frequency interventions”: Please more examples to facilitate understanding. Are these tasks that every patient does regardless of their care plan? Or are they specific to different goals? Can they be both?	LUMC	
In 2.1.2. the JITAIs in recommender engine need more elaboration. The idea is to adapt the frequency, content and type of interventions to the changing context and situation of the patient. How is this assessed? Self-management adherence? Patient satisfaction? How do we know whether these are productive/counter-productive?	LUMC	WP 3
In 2.3.1 UC4 Which risk scores will be used?	LUMC	
In 2.3.2. UC6 How to assess if a goal/action plan is SMART enough. We need to create our own criteria for what is sufficient specification or not. It has already been proposed that we use the SMART guidelines (Specific, Measurable, Attainable, Relevant, and Time-bound) and I agree with that but we need to clarify further for automatization within POWER2DM. Specific: What is specific enough? What criteria will we use to differentiate specific from non-specific labels? Measurable: What are quantifiable aspects of each specific activity? Is this chosen by the patient/doctor? Do we provide a list of measurement unit possibilities? How many options will be built into POWER2DM? Attainable: This is highly patient specific, so how does POWER2DM assess this? Relevant: This shouldn't be an issue as these goals are agreed upon with the physician so they should be relevant. Time-bound: How specific do we need to be? Is listing days enough? Are time periods like morning/afternoon/evening/night specific enough? Do we need specific hours to be given?	LUMC	WP3
Ch. 3.1. Table D1.1.1 SAS added some barriers specific for Type 2 DM.	SAS	clinical partners SAS & LUMC
Ch. 3.2. Persona Ana: In the Persona we see a lot of anxiety (afraid of hypos, afraid of CV events), that is not really dealt with in the treatment goal or committed actions... I think that might increase the chance of non-adherence.	LUMC	clinical partners SAS & LUMC
Ch. 3.2. Persona Rafael: “lose some weight” This is an extremely valuable clinical goal, but not a specific behavioral goal that a patient can strive for. That is important. So please RELATE this clinical treatment goal to a SPECIFIC BEHAVIORAL goal, that a patient can try to achieve, get feedback on, monitor, plan etc. “lose the fear to smartphone” We will somehow have to help him with that, or let someone else (partner/child) help him with that. We will have to make a small action plan on HOW to lose the fear. “adhere to lifestyle” In the POWER2DM intervention, this type of goal would not be specific enough. In order to have clear and valuable goals for patients, and the POWER2DM action plan engine to start with useful advises, we'll need a more specific behavioral goal (such as reduce carbs, or do more walking etc.) I think it is good when the doctor is involved in the specific goal setting, to make sure that patients do not set harmful goals.	LUMC	clinical partners SAS & LUMC
4.1.1. Anamnesis. See the various digital forms for anamnesis (as present in the 3 clinical settings). Good to check how/whether they overlap.	LUMC	
4.2.2. 5 Monitoring and self-management “POWER2DM checks whether the patients' personal values are clear. If no → POWER2DM value compass (APE = action plan engine)” It will be good to discuss whether POWER2DM will need to do this with every patient, and what it looks like.	LUMC	WP3
5.1.1. Peter scenario, OPTIONAL use of KADIS in shared decision making	SRDC	

<p>phase. In D1.2 the UC3 describes a possible way how KADIS can be used in co-decision making phase. In fact, it is the procedure applied in IDK already to provide an optimum medication plan and dietary intake plan (at least the time and total bread unit suggested for meals) for patient. From the Cordoba meeting, I understood that the only problem is the accuracy/validation of KADIS and LUMC will check this in the Quantification Campaign. So for the co-decision making phase, I think the scenario will be as follows;</p> <ul style="list-style-type: none"> <li>• Patient agrees to use KADIS and an action plan is registered for patient to prepare for KADIS Usage (<b>UC5.4</b>);             <ul style="list-style-type: none"> <li>○ KADIS Introduction Tour,</li> <li>○ For the 3 day period;                 <ul style="list-style-type: none"> <li>▪ Blood Glucose measurements by CGM or Glucometer (if glucometer plan the times to measure)</li> <li>▪ Logging calorie intakes for each meal</li> <li>▪ Logging insulin/medication intakes</li> <li>▪ Logging physical activity</li> </ul> </li> <li>○ Scheduling another co-decision making encounter with physician (After data is ready and Metabolic Fingerprint is calculated)</li> </ul> </li> <li>• KADIS Action plan is applied by the patient and data will be stored in Personal Data Store (Normal self management; action plan guidance, etc)</li> <li>• Creation of Metabolic Fingerprint (Blood Glucose Profile) for patient by going on a special procedure applied in <b>IDK by specialists</b> (From the last meeting we understood that this is a <b>manual</b> process); For pilot applications we need to decide whether this process will be done in IDK or by the corresponding clinic (LUMC in Netherlands, and SAS in Spain). In Cordoba Meeting, it was decided that IDK will perform the process for <b>Quantification Campaign</b>. In any way, the clinic will retrieve required patient data (deidentified) from Personal Data Store.</li> <li>• (<b>UC3</b>) In the scheduled co-decision making encounter, the physician together with patient analyse the Metabolic Fingerprint, simulate some medication plans and dietary intake plans to find the optimum daily glucose management. Then when physician decides on a medication plan and dietary intake plan, these decisions will be converted to POWER2DM Goals and Treatment Plan (take 15 mg insulin at 10:00, have your breakfast at 9 am do not exceed 300 calorie, etc) and stored in to the Personal Data Store.</li> </ul>		
<p>5.1.1. Peter scenario. In this example I miss the barrier (feeling sad) in the action plans... We will have to relate that more specifically in order to keep motivation for all these behaviors. HOW will it help him feeling less sad? The answer is not just: refer him to the medical psychologist.</p>	LUMC	
<p>5.1.2. Peter scenario – Week 1. “Peter has to indicate which health professionals take care of his diabetes and who are allowed access to his personal data.” This might be something that the diabetes specialist does for the patient.</p>	LUMC	
<p>5.1.2 Peter scenario – Month 2-4: “POWER2DM suggests that Peter asks a soccer friend to help him execute this plan, because it is quite an elaborated plan. This friend will also provide social support. Peter first does not like this suggestion, because he wants to be treated as a normal person by his friends, but he acknowledges that the help of his friend would be very supporting. Peter and his friend Whatsapp each other before a match and his friend helps him before and after the game with monitoring his glucose levels and balancing his food intake, soccer exercise and insulin shots” There should always be an option that Peter can say ‘not feasible’ when he really does not like the plan. POWER2DM should then provide suggestions for alternative plans.</p>	LUMC	
<p>Avatar: Which partner would be responsible for implementing the avatar?</p>	SRFG	
<p>6.1.2. Ana scenario – self-management phase: “Ana allows her internist to access her data.” The patient has to configure the Consent Editor. For specifying who has access to her patient data, e.g. the daughter, doctors, etc This should be done by a Consent Editor. We will need an UC for that, too. Be aware – the informed consent is not the same as the Consent Editor.</p>	SRFG	

## 8 REFERENCES

Abraham C & Michie S (2008). A taxonomy of behavior change techniques used in interventions. *Health Psychology, 27*(3):379-387.

Avery L, Flynn D, Dombrowski SU, Van Wersch A, Sniehotta FF & Trenell MI (2015). Successful behavioral strategies to increase physical activity and improve glucose control in adults with Type 2 diabetes. *Diabetes Medicine, 32*(8):1058-1062.

Free C, Philips G, Galli L, Watson L, Felix L, Edwards P, Patel V & Haines A (2013). The effectiveness of mobile-health technology-based health behavior change or disease management interventions for health care consumers: A systematic review. *Plos medicine*, <http://dx.doi.org/10.1371/journal.pmed.1001362>.

Nahum-Shani, S., Smith, S. N., Tewari, A., Witkiewitz, K., Collins, L. M., Spring, B., & Murphy, S. A. (2014). *Just-in-time adaptive interventions (JITAI): An organizing framework for ongoing health behavior support*. (Technical Report No. 14-126). University Park, PA: The Methodology Center, Penn State.