



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 D4.1 (or D4.1.1)

Personal Data Model and Service API

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Contributors (Benef.) Tuncay Namlı (SRDC)
 Gokce Banu Laleci Erturkmen (SRDC)
 Suat Gönül (SRDC)
 Dietmar Glachs (SRFG)
 Felix Strohmeier (SRFG)
 Bob Mulrenin (SRFG)
 Albert De Graaf (TNO)
 Lutz Vogt (IDK),
 Eckhard Salzsieder (IDK)

Responsible Author Tuncay Namlı

Email tuncay@srdc.com.tr

POWER2DM Consortium Partners

Abbv	Participant Organization Name	Country
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

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1 PURPOSE

The common patient data that needs to be shared among all POWER2DM system components will be stored in POWER2DM Personal Data Store component. **The purpose of this deliverable is to define the common data model and an interoperability specification for data exchange mechanisms and format for this common data store.** In this way, data interoperability will be achieved between other components of POWER2DM with POWER2DM Personal Data Store.

Rather than defining proprietary data model and service APIs, we prefer to build POWER2DM Personal Data Store common data model and data exchange mechanisms on HL7 Fast Healthcare Interoperability Exchange (FHIR) as a base standard (HL7 FHIR DSTU 2)¹. Therefore, in this deliverable, we define how HL7 FHIR is used to represent the required data elements for POWER2DM and how FHIR data exchange mechanisms are used to define a Data Exchange Service API. Furthermore, we use the FHIR's profiling and extension mechanisms to define a stricter specification that will enable plug-and-play interoperability between the POWER2DM components.

2 REFERENCE DOCUMENTS

The following documents were used or referenced in the development of this document:

- HL7 FHIR DSTU2¹
- D1.1 User Requirements and Use Case Scenarios
- D1.2 Requirement Specification of POWER2DM Architecture
- D5.2 Quantification Campaign

2.1 Definitions and Acronyms

Table 1 List of Abbreviations and Acronyms

Abbreviation/ Acronym	DEFINITION
FHIR	Fast Healthcare Interoperability Exchange
HL7	Health Level 7
CGM	Continuous Glucose Monitoring
DM-QOL	Diabetes Management Quality of Life
API	Application Programming Interface
JWT	JSON Web Token
PDS	POWER2DM Personal Data Store
VAS	Visual Analog Scale
ODL	Observation of Daily Life
LDL-C	Low Density Lipoprotein Cholesterol
HDL-C	High Density Lipoprotein Cholesterol
TC	Total Cholesterol
TG	Total Triglyceride
FFA	Free Fatty Acid
UACR	Urine Albumin Creatinine Ratio
GFR	Glomerular Filtration Rate
T1D	Type 1 Diabetes

¹ <https://www.hl7.org/fhir/index.html>

3 POWER2DM DATA MODEL

3.1 Overview

Our methodology for the definition of data model for POWER2DM Personal Data Store is as follows;

- **Identification of record types** to be shared within POWER2DM components and link them to POWER2DM use cases.
- Definition of **“POWER2DM Conceptual Personal Data Model”**: We start with the definition of high level conceptual data model that describes data entities and relationship among these entities to represent the identified record types.
- Definition of **“POWER2DM Logical Personal Data Model”**: In this model more detail will be provided regarding the data entities, specifically their data elements, cardinalities, types and meanings. However, note that this is still not the physical data model which means these are not used to materialize content into exchanged medical records. This is for all readers including clinicians to understand the content of entities and what they represent.
- Definition of **“POWER2DM Physical Personal Data Model”**: This part defines how POWER2DM Logical Data Model is represented by using the FHIR as base specification and defining FHIR profiles² (extensions or restrictions) when necessary to adapt the base resource definitions for POWER2DM context. This model is for developers to understand how they can implement their components to consume or create these records and for others to understand the data to be collected or stored in POWER2DM.

The following subsections elaborate each of the above concepts in detail:

3.2 POWER2DM Personal Data Record Types

Table 2 lists the record types required to represent patient data collected or originated during POWER2DM care program.

Table 2 POWER2DM Personal Data Record Types

Identification data	
Patient	Basic demographic data like name, age, gender, etc.
Practitioner	Basic information (name, etc.) related with care provider that take role in POWER2DM Care Program
Organization	Basic information about healthcare organization that take role in POWER2DM Care Program
Device	Basic information about the individual personal health devices used in POWER2M or POWER2DM components (information system) that generates data (prediction, calculation)
Workflow/Care management related data	
Problem	Identified diabetes related problems like “too much carbohydrates”, “low dose insulin”, etc.
Barrier	Identified psychological and socio-demographic barriers like “fear hypos”, “lack of social support”
Personal Value	Identified personal value (e.g. Anna wants to have children within the next few years, but currently her HbA1c is too high)
Treatment Goal	Each long-mid-short term treatment goal specified in shared decision making
Self-Management Goal	Each self-management goal specified by patient
Treatment Action Plan	Each committed action agreed in shared decision making

² <https://www.hl7.org/fhir/profiling.html>

Self-Management Plan	Action	Record for each action planned by patient
Medication Order		Insulin and diabetic medication instructions stating the medication, time and dosing
Appointment Encounter		Appointment of patient with a care provider Record for face-to-face encounters of patient and a care provider
Applied Intervention		Record for applied digital interventions (by/via POWER2DM system or within the POWER2DM care program) to patient
Questionnaire		Organized collection of questions intended to solicit information from patients in POWER2DM (either in shared-decision making phase or self-management phase via interactive questions over mobile phone or web application)
Diabetes Anemnesis		Age, Gender, Height, Type of Diabetes, Medical History (Time since diagnosis/ Complications/ Physical examination/Comorbidities), Variables needed for risk models (Y/N treated hypertension, Y/N retinopathy, Age at completion of formal education, diabetes duration, Y/N atrial fibrillation, Y/N smoking, Y/N lipid lowering therapy)
Observations (produced during self-management; patient reported or device measurements)		
CGM Results		All CGM data (time series) for each episode of CGM usage.
Blood Glucose (strips)		Result of each blood glucose measurement
Body Weight		Result of each body weight measurement
Heart rate (pulse)		Result of each heart rate measurement
Body Temperature		Result of each body temperature measurement
Blood Pressure		Result of each blood pressure measurement (systolic + diastolic)
Physical Activity (manually by patient)		Data for episode of physical activity. Requires subtypes based on terminology e.g. jogging.
Activity Tracker (daily summary via tracking device)		Data collected from physical activity tracker device; # of steps, distance covered, etc.
Dietary Intake		Record of dietary intake including details about ingredients (calorie, etc)
Sleep Tracker (daily)		Sleep summary data for each night collected by the sleep tracker
Sleep Quality VAS		Data logged by patient to evaluate his/her sleep quality
Breathing		Time series data from device (e.g. Spire)
Waist circumference		Result of each waist measurement
Complaint		Manually logged diabetes related complaint by patient. Manually reported with start date, today's date; or start and end period. This will be useful for consultation with doctor. It can also include notes / open issues to be discussed with a care person during next consultation or online.
Relaxation/Stress Tracker		Data collected from stress tracking device
Stress VAS		Manually logged stress level by patient
Mood VAS		Manually logged emotion by patient
Medication Administration		Manually logged insulin/diabetic medication intake record
Questionnaire Result		The result of questionnaire applied to patient
Acknowledgement		An acknowledgement about the performance and completion status of a planned or unplanned activity in the patient's action plan. Manually logged by patient. This handle typed activities that do not require a typed ODL form. Type, subtype ...
Clinical results (produced in shared-decision making phase)		
HbA1c		HbA1C lab result
Cholesterol		Cholesterol/lipid panel lab results (LDL-C, HDL-C, TC, TG, FFA)

Urine Test Results for Kidney	Lab results for urine tests (albumin, creatinine (for UACR), GFR)
Gut health measure	Result of gut health measurement
Systolic & Diastolic BP	Blood pressure measurements done in clinic settings
Inflammation markers	Results related with inflammation markers like hs-CRP, adipokines
Other Diabetic Indicators	Fasting glucose, fasting insulin, insulin sensitivity, beta cell function,
Tissue Damage Markers	TC, HDL-C, LDL-C, TG, liver damage blood markers, neuropathy markers, smoking status
Psychological Health Observations	Observations of patient's psychological health (see POWER2DM Personas)
Socio Demographic Observations	Observations of patient's socio demographic situation
KADIS QScore Results	The results of QScore calculations
Applied Questionnaire's Score	The scores calculated from the applied questionnaire
KADIS Metabolic Fingerprint	The time series blood glucose data predicted by KADIS at specific time
KADIS Blood Glucose Prediction	The time series blood glucose data predicted by KADIS at specific time
MARVEL Prediction Results	The prediction results of MARVEL at specific time
UKPDS Risk Scores	Calculated risk scores from UKPDS model at specific time
ADVANCE Risk Engine Scores	Calculated risk scores from Advance Risk Engine at specific time
Major Outcomes T1D Risk predictor	Calculated risk scores from Major Outcomes T1D model at specific time

3.3 Conceptual Data Model

Considering the content of these entities (commonalities in their semantics and purpose) we come up with a conceptual model as shown in Figure 1. Then each data entity is briefly described and its relationships with other data entities are listed.

3.3.1 Identification Data Entities

“Patient” is the data entity indicating the basic demographic information about patient.

- All other data entities apart from other identification data entities refer to “Patient” to indicate that the patient is the subject of the record.

“Practitioner” is the data entity indicating the basic information about a care provider. Some of the other data entities may refer practitioner.

- “Practitioner” fulfils his/her roles within an organization and this relationship should be specified.

“Organization” is the data entity indicating the basic information about a healthcare organization take some part in POWER2DM care program.

“Device” is the data entity representing basic information about an individual medical device or information system that can measure or produce data.

- For personal health devices used by patient, record will refer to the “Patient” that use the device.

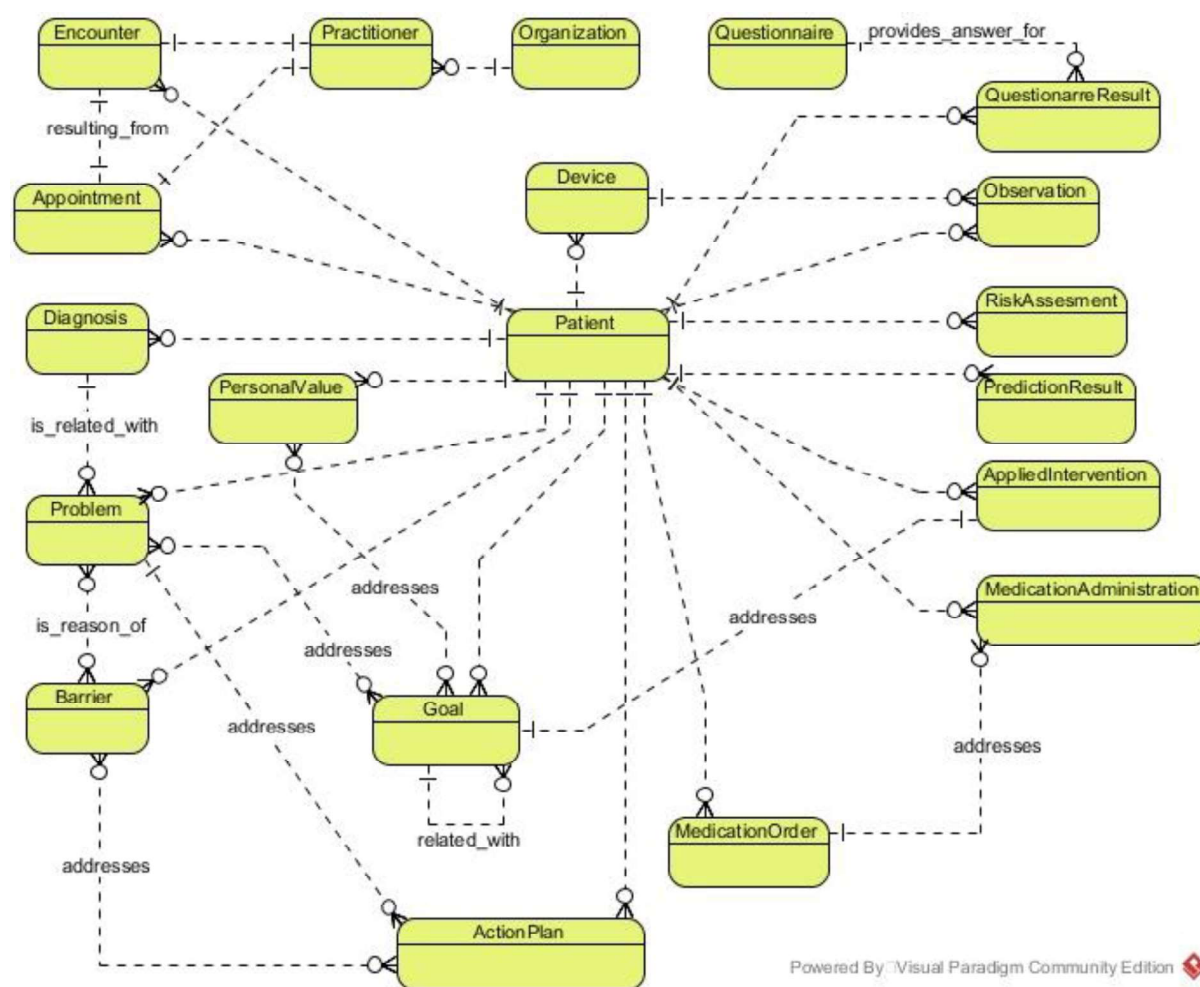


Figure 1 POWER2DM Conceptual Data Model

3.3.2 Workflow/Care Management Data Entities

“Diabetes Anamnesis” is the data record which includes basic information regarding patients’ diabetes history; diagnosis assigned to patient, diagnosis indicating complications or comorbidities, Age, Gender, Height, etc.

“Condition (Diagnosis)” is the data entity which includes a diabetes related condition of the patient. Patient may have multiple condition records where one of them should be the main diagnosis indicating the type of diabetes and others indicating complications or comorbidities.

“Problem” is the data entity that indicates the patient’s specific problem in relation to his/her diabetes (ex: high stress, too little exercise, too little glucose monitoring, high cholesterol, etc.).

- This data entity may be correlated (is_related_with) with one of patient’s diagnosis record.

“Barrier” is the data entity indicating patient’s barrier identified during POWER2DM care program.

- “Barrier” can be a reason of a number of identified “Problem” (e.g. lack of motivation/time for exercise, feeling sad about continuous burden of DM) and this relationship (is_reason_of) should be set if so.

“Personal Value” is the data entity indicating the patient’s personal value (e.g. having a child in near future, being around with friends) in his life which will be basis for his/her self-management goals and activities.

“Goal” is the data entity indicating a diabetes care related goal set for patient to reach at some time or within a period. This conceptual entity includes both “Treatment Goals” set together by care provider and patient during shared-decision making e.g. becoming more active, monitoring blood glucose regularly; and also “Self-management Goals” set by patient himself/herself e.g. being more careful about the dinners. As their semantics and content will be same, we merge these concepts into a single data entity.

- A specific data element will refer the author (Patient or Practitioner) of the goal which then indicates whether it is a treatment goal or self-management goal
- A “Goal” may address one or more identified “Problem” of patient which means that this goal is set to support the resolution of problem.
- A “Goal” may address one or more “Personal Value” of patient which means that this goal is set to help him/her to reach that personal value.
- A “Goal” may be related with one or more “Goal” to indicate that reaching the goal will help to reach the other goal (Long-term goal & short-term goal relationships).

“Action Plan” is the data entity indicating an action planned for patient at specific time. This data entity both includes the planned actions during shared-decision making (Treatment Action Plan) e.g. bringing family members to consultation, buying a pedometer and measuring the step count) and planned actions by patient himself (Self-management Action Plan) e.g. walking 1 hour at weekends, walking with dog 2 times a day, at least 3 times a week.

- A specific data element will indicate the type of action plan; Treatment Action Plan or Self-Management Action Plan
- An “ActionPlan” may address one or more identified “Goal” indicating that this planned action will help to reach the goal
- An “ActionPlan” may address one or more identified “Barrier” indicating that this action is to support the resolution of the barrier.
- An “ActionPlan” may address an identified “Problem” indicating that this action is to support the resolution of the problem.
- An “ActionPlan” may address an identified “Complaint indicating that this action is to support the resolution of the problem.

“Medication Order” is the data entity indicating the insulin/medication instructions specified by a care provider for the patient including the specification of medication, dosage and timing.

“Appointment” is the data entity indicating the appointments of patient for face-to-face encounters with care providers.

“Encounter” is the data entity indicating the information for the encounters between patient and care providers.

- An “Encounter” may be realization of an “Appointment”

“Applied Intervention” is the data entity providing details (time, type of intervention, patient’s reaction) about the digital intervention delivered to patient.

- An “Applied Intervention” may address a “Goal” to indicate the intervention is applied to have some progress in that specific Goal.

“Questionnaire” is the data entity providing a structured definition for a questionnaire including questions, their orders and grouping and constraints on answers.

3.3.3 Data Entities for Observations of Daily Life and Clinical Results

“Observation” is the data entity that is basis model for all type of observations logged in POWER2DM. When required this base data entity may be specialized/extended for specific type of observation. These observations include the followings (descriptions of record types are given in Table 2);

- CGM Result
- Blood Glucose (strips)
- Body Weight
- Heart rate (pulse)
- Body Temperature
- Blood Pressure
- Physical Activity
- Dietary Intake
- Sleep Tracker (daily summary)
- Sleep Quality VAS
- Waist Circumference
- Breathing
- Complaint
- Relaxation/Stress Tracker
- Stress VAS
- Emotional VAS
- Mood/Motivation VAS
- Acknowledgement
- HbA1c
- Cholesterol
- Other Diabetic Indicators
- Urine Test Results for Kidney
- Tissue Damage Markers
- Body Height
- Psychological Health Observations
- Socio Demographic Observations
- KADIS QScore Results
- Questionnaire Scores
- Systolic and Diastolic BP
- Inflammation markers
- Gut Health Measure

“Risk Assessment” is the data entity indicating the results of risk assessments/calculations done for patient within the POWER2DM Care program. This includes the calculations with UKPDS and Advance Risk Assessment Models.

“Prediction Result” is the data entity indicating the prediction results from Marvel and KADIS models.

“Questionnaire Result” is the data entity indicating the questionnaire applied to patient including their answers.

- A “Questionnaire Result” should refer a “Questionnaire” to indicate that it gives the answers for that questionnaire

“Medication Administration” is the data entity indicating the administration of a medication by patient including time and actual dose taken.

- It may refer “Medication Order” to indicate the prescription that this medication intake is about.

3.4 Physical Data Exchange Model

In this section, we will provide details how the POWER2DM Conceptual Data Model will be implemented as a physical data exchange model based on FHIR specifications. During the implementation of POWER2DM system, the model may have slight changes. Therefore, we provide the model in an excel file³ (published internally for POWER2DM experts) which makes it easier to navigate through the data model definitions. The data model is also published from a portal⁴,

³

https://365tno.sharepoint.com/teams/pdm/WP4/T4.1%20Personal%20Data%20Store%20and%20Service%20for%20Data%20Access%20or%20Update%20-%20Lead%20SRDC/POWER2DM_Personal_Health_Data_Model-v1.3.xlsx?d=w6f3bd6d59d754ebcb4f0ce84ef9a7f34

⁴ <https://simplifier.net/POWER2DM?fhirstatus=Final&category=StructureDefinition|Extension>

Simplifier.net, which is a registry for FHIR based projects and provide a pretty view for their profile definitions.

3.4.1 FHIR Overview

The basic building block in FHIR standard is a “**Resource**” which is smallest unit of exchangeable content between healthcare systems. FHIR standard defines several common resources so that different healthcare system implementers can use them to represent their data in their use cases. For example, Observation⁵, Medication⁶, CarePlan⁷ are some clinical resource definitions, while Patient⁸, Practitioner⁹, Organization¹⁰ are defined for identification of entities, and Encounter¹¹, Appointment¹², Order¹³ are resource definitions for workflow management. Each resource can be used in different use cases.

“For example, *expected uses for the Observation resource include:*

- *Vital signs: temperature, blood pressure, respiration rate*
- *Laboratory Data*
- *Imaging results like bone density or fetal measurements*
- *Devices Measurements such as EKG data or Pulse Oximetry data*
- *Clinical assessment tools such as APGAR*
- *Personal characteristics: height, weight, eye-color*
- *Social history: tobacco use, family supports, cognitive status*
- *Core characteristics: pregnancy status, death assertion”*

“While base FHIR specification describes a set of these base resources and APIs that are used in many different contexts in healthcare, there is wide variability between jurisdictions and across the healthcare ecosystem around practices, requirements, regulations, education and what actions are feasible and/or beneficial. For this reason, FHIR specifications usually requires further adaptation to particular contexts of use. Typically, these adaptations specify:

- *Rules about which resource elements are or are not used, and what additional elements are added that are not part of the base specification*
- *Rules about which API features are used, and how*
- *Rules about which terminologies and used in particular elements*
- *Descriptions of how the Resource elements and API features map to local requirements and/or implementations”*

For more information, please consult to developer introduction in FHIR web site¹⁴.

In POWER2DM, we use this profiling mechanism to define the FHIR based physical data exchange model, the resource profiles, tailored for the requirements of POWER2DM. In these resource definitions, the data elements, the FHIR element path for them, their cardinalities, data types and the value sets to be used are defined.

⁵ <https://www.hl7.org/fhir/observation.html>

⁶ <https://www.hl7.org/fhir/medication.html>

⁷ <https://www.hl7.org/fhir/careplan.html>

⁸ <https://www.hl7.org/fhir/patient.html>

⁹ <https://www.hl7.org/fhir/practitioner.html>

¹⁰ <https://www.hl7.org/fhir/organization.html>

¹¹ <https://www.hl7.org/fhir/encounter.html>

¹² <https://www.hl7.org/fhir/appointment.html>

¹³ <https://www.hl7.org/fhir/order.html>

¹⁴ <https://www.hl7.org/fhir/overview-dev.html>

3.4.2 Overview of FHIR Resource Profiles for POWER2DM

Table 3 lists all the FHIR resource profiles defined for POWER2DM Personal Data Store. PDS will only support the resource contents that conforms to any of these resource profiles. The URI for the resource profiles is as follows (the base URI + the ResourceProfileName);

<https://www.power2dm.eu/pds/StructuredDefinition/<ResourceProfileName>>

Table 3 List of POWER2DM Resource Profiles

Resource Profile Name	Section	Base FHIR Resource
POWER2DM-Patient	3.4.3.1	Patient
POWER2DM-Practitioner	3.4.3.2	Practitioner
POWER2DM-Organization	3.4.3.3	Organization
POWER2DM-Device	3.4.3.4	Device
POWER2DM-DiabetesAnamnesis	3.4.4.1	Composition
POWER2DM-Condition	3.4.4.2	Condition
POWER2DM-Problem	3.4.4.3	Condition
POWER2DM-Barrier	3.4.4.4	Condition
POWER2DM-Complaint	3.4.4.5	Condition
POWER2DM-PersonalValue	3.4.4.6	Observation
POWER2DM-Goal	3.4.4.7	Goal
POWER2DM-ActionPlan	3.4.4.8	ProcedureRequest
POWER2DM-MedicationOrder	3.4.4.9	MedicationOrder
POWER2DM-Appointment	3.4.4.10	Appointment
POWER2DM-Encounter	3.4.4.11	Encounter
POWER2DM-SimpleQuantityObservation	3.4.5.1.1	Observation
POWER2DM-SimpleCodedObservation	3.4.5.1.2	Observation
POWER2DM-TimeSeriesObservation	3.4.5.1.3	Observation
POWER2DM-BloodPressure	3.4.5.1.4	Observation
POWER2DM-TrackerHeartRateSummary	3.4.5.1.5	Observation
POWER2DM-DietaryIntakeLog	3.4.5.1.6	Observation
POWER2DM-PhysicalActivityLog	3.4.5.1.7	Observation
POWER2DM-ActivityTrackerDailySummary	3.4.5.1.8	Observation
POWER2DM-SleepTrackerSleepSummary	3.4.5.1.9	Observation
POWER2DM-MindState	3.4.5.1.10	Observation
POWER2DM-QuestionnaireResult	3.4.5.1.11	Observation
POWER2DM-Acknowledgement	3.4.5.2	Procedure
POWER2DM-RiskAssesment	3.4.5.3	RiskAssesment
POWER2DM-PredictionResult	3.4.5.4	RiskAssesment
POWER2DM-QuestionnaireResponse	3.4.5.5	QuestionnaireResponse
POWER2DM-MedicationAdministration	3.4.5.6	MedicationAdministration
POWER2DM-AppliedIntervention	3.4.5.7	Procedure
POWER2DM-KADISBaselineDataset	3.4.5.8	Composition
POWER2DM-KADISFingerprintOrder	3.4.5.9	Order
POWER2DM-KADISFingerprintOrderResponse	3.4.5.10	OrderResponse
POWER2DM-CommunicationPreference	3.4.5.11	CommunicationRequest
POWER2DM-UserSettings	3.4.5.12	Basic

The following sections provide the details regarding the content of these resource profiles in tables.

- **“FHIR Path”** shows the path (JSON path) of the data element in the resource.
- **“Card.”** Shows the cardinality of data element in the resource or container data element
- **“FHIR Data Type”** indicates the FHIR data type (See FHIR Data Types¹⁵)
- **“FHIR Extensions”** part indicate the extensions defined over the original resource profile for POWER2DM requirements. See the FHIR documentation¹⁶ to better understand the extensibility mechanism.

¹⁵ <https://www.hl7.org/fhir/datatypes.html>

¹⁶ <https://www.hl7.org/fhir/extensibility.html>

For example, in Section 0, an extension call POWER2DM_relatedProblem is defined for Barrier resource profile. The serialized JSON snippet to be included in the resource will be as follows;

```

"extension": [
  {
    "url": https://www.power2dm.eu/pds/StructureDefinition/POWER2DM\_relatedProblem
    "valueReference": "Problem/242"
  }
]

```

3.4.3 FHIR Resource Profiles for POWER2DM Identification Data Entities

3.4.3.1 Patient Resource Profile (Profiling FHIR Patient⁸ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Patient.active	1..1	boolean	True if patient is still within the POWER2DM Care program, false if he/she abandons the program
Patient.gender	1..1	code	Patient's gender (male female other)
Patient.birthDate	1..1	date	Patient's birth year
Patient.maritalStatus	0..1	CodeableConcept	Patient's marital status (see ¹⁷ for possible value set)
FHIR Extensions			
Patient.ethnicity	1..1	POWER2DM_ethnicity	Ethnicity of patient
Patient.ethnicity.valueCodeableConcept	1..1	CodeableConcept	The code identifying the ethnicity of patient. See Table 4.

Table 4 POWER2DM Value set for Patient.ethnicity extension

Meaning	Code
White	white
Afro-caribbean	afro-caribbean
Asian-indian	asian-indian
Other	other

3.4.3.2 Practitioner Resource Profile (Profiling FHIR Practitioner⁹ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Practitioner.name	1..1	HumanName	Full name of practitioner (use given and family)
Practitioner.practitionerRole	1..1	BackboneElement	Provides information about the role of the practitioner
Practitioner.practitionerRole.managingOrganization	1..1	Reference (Organization)	Reference to an Organization entity where this practitioner is working for
Practitioner.practitionerRole.role	1..1	CodeableConcept	Practitioner's role in POWER2DM care program (See Table 5 for value set)

Table 5 POWER2DM value set for Practitioner Role

Meaning	Code
---------	------

¹⁷ <http://hl7.org/fhir/valueset-marital-status.html>

Physician	physician
Diabetes Nurse	nurse
Prediction Model Specialist	model-specialist

3.4.3.3 Organization Resource Profile (Profiling FHIR Organization¹⁰ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Organization.name	1..1	string	Name of the organization

3.4.3.4 Device Resource Profile (Profiling FHIR Device¹⁸ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Device.patient	0..1	Reference (Patient)	Refer the corresponding "Patient" if this device is affixed to the patient
Device.type	1..1	CodeableConcept	Identifies the type of the device (see Table 6)
Device.model	0..1	string	Model name of the device
Device.manufacturer	0..1	string	Manufacturer of the device
Device.identifier.value	1..1	string	Serial number (Or any unique number) assigned to device
Device.owner	0..1	Reference (Organization)	Organization responsible for device. If device is owned by patient, leave empty.

Table 6 POWER2DM Value set for Device Types

Meaning	Code (SNOMED-CT)
Continuous Glucose Monitoring Device	700585005
Blood Glucose Meter (Fingerprick)	354068006
Blood Pressure Monitor	258057004
Activity Tracker	462329005
Weight Scale	464526001
Breath Sensor	2468001
Information System (IT)	706593004

3.4.4 FHIR Resource Profiles for POWER2DM Workflow/Care Management Data Entities

3.4.4.1 Diabetes Anamnesis Resource Profile (Profiling FHIR Composition¹⁹ as base resource)

This record is designed as clinical document that refers a set of resources related with diabetes anamnesis.

FHIR Path	Card.	FHIR Data Type	Description
Composition.date	1..1	dateTime	Editing time of this summary
Composition.type	1..1	CodeableConcept	Use fixed "34861-5" (LOINC Diabetology Note) as the code to indicate the type of this record
Composition.title	1..1	string	Use "POWER2DM Diabetes Anamnesis"
Composition.status	1..1	code	Use fixed "final" as the code to indicate the status of the report
Composition.subject	1..1	Reference (Patient)	Reference to the patient this report is about

¹⁸ <https://www.hl7.org/fhir/device.html>

¹⁹ <https://www.hl7.org/fhir/composition.html>

Composition.author	1..1	Reference (Practitioner)	Reference to the Practitioner who authored the report
Composition.section[1]	1..1	BackboneElement	The report section that will include the type of diabetes
Composition.section[1].title	1..1	string	Use "Type of Diabetes"
Composition.section[1].entry	1..1	Reference (Condition)	Reference to the condition record that indicates the type of diabetes and the data of diagnosis
Composition.section[2]	1..1	BackboneElement	The report section that will include the complications
Composition.section[2].title	1..1	string	Use "Diabetes Complications"
Composition.section[2].entry	0..*	Reference (Condition)	Reference to the condition records indicating the complications patient have
Composition.section[3]	1..1	BackboneElement	The report section that will include the comorbidities
Composition.section[3].title	1..1	string	Use "Comorbidities"
Composition.section[3].entry	0..*	Reference (Condition)	Reference to the condition records indicating the comorbidities patient have
Composition.section[4]	1..1	BackboneElement	The report section that will include the basic Diabetes related observations (Smoking, Body Height, etc)
Composition.section[4].title	1..1	string	Use "Diabetes Related Observations"
Composition.section[4].entry	0..*	Reference (Observation)	Reference to the observation records that includes the related observations

3.4.4.2 Condition(Diagnosis) Resource Profile (Profiling FHIR Condition²⁰ as base resource)

FHIR Path	Card.	FHIR Type	Data	Description
Condition.patient	1..1	Reference (Patient)		Reference to the patient who has this diagnosis
Condition.category	1..1	CodableConcept		Use fixed code "diagnosis" (Code System: http://hl7.org/fhir/condition-category). See Table 7
Condition.code	1..1	CodableConcept		Identification of diagnosis (see Table 8)
Condition.onset[x]	1..1	dateTime Age		Either Date or Age for the onset of disease
Condition.clinicalStatus	0..1	code		Status of the condition (active relapse remission resolved)
Condition.verificationStatus	1..1	code		Use fixed value "confirmed" from ConditionVerificationStatus code list
Condition.notes	0..1	string		Additional information about the Diagnosis

Table 7 POWER2DM Value set for Condition Categories

Meaning	Code
Diagnosis	diagnosis
Problem	problem
Barrier	barrier
Complaint	complaint

²⁰ <https://www.hl7.org/fhir/condition.html>

Table 8 POWER2DM Value set for Diagnosis.code (based on 2016 ICD-10-CM Diagnosis Codes)

Meaning	Code
Type of Diabetes	
Type 1 diabetes mellitus	E10
Type 2 diabetes mellitus	E11
Complications	
Kidney complications	E11.2
Retinopathy	E11.3
Neurological complications	E11.4
Circulatory complications	E11.5
Other complications	E11.6
Comorbidities	
Hypertension	I10
Atrial Fibrillation	I48
High Cholesterol	E78

3.4.4.3 Problem Resource Profile (Profiling FHIR Condition as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Condition.patient	1..1	Reference(Patient)	Reference to the patient who has this problem
Condition.asserter	0..1	Reference(Practitioner)	Reference to the physician who enters this problem
Condition.category	1..1	CodeableConcept	Use fixed code "problem" (See Table 7)
Condition.code	1..1	CodeableConcept	Identification of problem with a coded value (See Table 9)
Condition.clinicalStatus	1..1	code	Status of the problem (active relapse remission resolved)
Condition.verificationStatus	1..1	code	Use "confirmed" from ConditionVerificationStatus code list if problem is confirmed or entered by Physician
Condition.severity	0..1	CodeableConcept	Severity of problem (severe moderate mild)
Condition.onsetDateTime	1..1	dateTime	Date time indicating the onset of this problem
Condition.abatementDateTime	0..1	dateTime	Date time this problem is resolved (if resolved)
Condition.notes	0..1	string	Additional textual information about the problem
FHIR Extensions			
Condition.relatedCondition	0..*	POWER2DM_relatedCondition	Extension to indicate the related condition
Condition.relatedCondition.valueReference	1..1	Reference(Condition)	Reference to Condition record that this problem is related with
Condition.relatedProblem	0..*	POWER2DM_relatedProblem	Extension to indicate the related problem
Condition.relatedProblem.valueReference	1..1	Reference(Problem)	Reference to the Problem record that this problem may be a reason for that problem

Table 9 POWER2DM Value set for Problem Codes

Meaning	Code	Code System
Insulin/Medication related problem		
Low dose insulin/medication	448152000	SNOMED-CT
Low frequency insulin/medication	med-low-freq	POWER2DM
High dose insulin/medication	448089004	SNOMED-CT
High frequency insulin/medication	med-high-freq	POWER2DM
Carbohydrates Related Problem		
Too few carbohydrates	66539004	SNOMED-CT
Too much carbohydrates	226120004	SNOMED-CT
Dietary related problem (N.B. based on weekly averages)		
Total calorie intake too high	68097001	SNOMED-CT
Total fat consumption too high	226097005	SNOMED-CT
Saturated fat (percentage of total fat) too high	162517003	SNOMED-CT
Fiber intake too low	15108003	SNOMED-CT
Sugars (% of carbohydrates) too high	412744006	SNOMED-CT
Alcohol consumptions too many	160592001	SNOMED-CT
Salt consumption too high	226157005	SNOMED-CT
Vegetable intake too low	veg-low	POWER2DM
Peas/beans intake too low	peas-low	POWER2DM
Fruit intake too low	fruit-low	POWER2DM
Nuts intake too low	nuts-low	POWER2DM
Glucose related monitoring problem		
Too little glucose monitoring	bgm-little	POWER2DM
Too much glucose monitoring	bgm-much	POWER2DM
Exercise related problem		
Too little exercise	activity-little	POWER2DM
Too much exercise	activity-much	POWER2DM
Stress related problem		
Too much stress	73595000	SNOMED_CT
Sleep quality too low	sleep-low	POWER2DM
Other problems		
Blood pressure too high	38341003	SNOMED_CT
Blood lipids too high	lipids-high	POWER2DM

3.4.4.4 Barrier Resource Profile (Profiling FHIR Condition as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Condition.patient	1..1	Reference (Patient)	Reference to the patient who has this problem
Condition.asserter	0..1	Reference (Practitioner)	Reference to the physician who enters this barrier (if not saved by SMSS)
Condition.category	1..1	CodeableConcept	Use fixed value "barrier" (See Table 7)
Condition.code	1..1	CodeableConcept	Identification of barrier with a coded value (See Table 10)
Condition.clinicalStatus	1..1	code	Status of the barrier (active relapse remission resolved)
Condition.verificationStatus	1..1	code	Use "confirmed" from ConditionVerificationStatus code list if problem is confirmed or entered by Physician
Condition.severity	0..1	CodeableConcept	Severity of barrier (severe moderate mild)
Condition.onsetDateTime	1..1	dateTime	Date this barrier is identified or recorded
Condition.abatementDateTime	0..1	dateTime	Date this barrier is resolved (if resolved)
Condition.notes	0..1	string	Additional textual information about the barrier, required if code is selected as "Other"
FHIR Extensions			
Condition.relatedProblem	0..*	POWER2DM_relatedProblem	Extension to indicate the related problem
Condition.relatedProblem.valueReference	1..1	Reference (Problem)	Reference to the Problem record that this barrier may be a reason

Table 10 POWER2DM Value set for Barrier Codes

Meaning	Code	Code System
Fear hypos	fear-hypos	POWER2DM
Fear hypers	fear-hypers	POWER2DM
Fear needles	279926005	SNOMED-CT
Fear weight	247824007	SNOMED-CT
Negative affect	neg-affect	POWER2DM
Fear disclosure	fear-disclosure	POWER2DM
Forgetting	55533009	SNOMED-CT
Conflicting life goals	conf-life-goal	POWER2DM
Lack of time	lack-time	POWER2DM
Lack of energy	248274002	SNOMED-CT
Other	74964007	SNOMED-CT

3.4.4.5 Complaint Resource Profile (Profiling FHIR Condition as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Condition.patient	1..1	Reference (Patient)	Reference to the patient who has this complaint
Condition.category	1..1	CodeableConcept	Use fixed code "complaint". See Table 7
Condition.code	1..1	CodeableConcept	Identification of complaint with a coded value. See Table 11

Condition.clinicalStatus	1..1	code	Status of the problem (active relapse remission resolved)
Condition.verificationStatus	1..1	code	Use fixed value “confirmed” from ConditionVerificationStatus code list
Condition.severity	0..1	CodeableConcept	Severity of problem (severe moderate mild)
Condition.onsetDateTime	1..1	dateTime	Date time indicating the onset of this problem
Condition.abatementDateTime	0..1	dateTime	Date time this problem is resolved (if resolved)
Condition.notes	0..1	string	Additional textual information about the complaint

Table 11 POWER2DM Value set for Complaints

Meaning	Code (SNOMED)
Sweating	415690000
Rapid pulse	86651002
Shakiness, dizziness, weakness	13791008
Decreased coordination	422576004
Difficulty concentrating	247761005
Blurred vision	111516008
Headache	25064002
Trouble performing routine tasks	225789002

3.4.4.6 Personal Value Resource Profile (Profiling FHIR Observation as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Observation.subject	1..1	Reference (Patient)	Reference to the patient who has this personal value
Observation.code	1..1	CodeableConcept	Use fixed SNOMED-CT code 31614008 (Personal Motivation) to indicate that this observation indicates a personal value of patient
Observation.status	1..1	Code	Use fixed code “final”
Observation.effectiveDateTime	1..1	dateTime	Date this personal value is recorded
Observation.component[0]	1..1	BackboneElement	
Observation.component[0].code	1..1	CodeableConcept	Use fixed SNOMED-CT code 31614008 (Personal Motivation) to indicate that this component indicates a personal value of patient
Observation.component[0].valueCodeableConcept	1..1	CodeableConcept	Description of the personal value as text or coded value
Observation.component[1]	1..1	BackboneElement	The component indicating the importance of personal value
Observation.component[1].code	1..1	CodeableConcept	Use fixed SNOMED-CT code 247752005 (Level of Interest) to indicate that this component gives the importance of personal value
Observation.component[1].valueQuantity	1..1	Quantity	The value for importance of personal value

Observation.component[2]	1..1	BackboneElement	The component indicating the contentment of personal value
Observation.component[2].code	1..1	CodeableConcept	Use fixed SNOMED-CT code 406193000 (Client satisfaction) to indicate that this component gives the contentment of personal value
Observation.component[2].valueQuantity	1..1	Quantity	The value for contentment of personal value

Table 12 Components of PersonalValue resource

Components	Card.	Units (UCUM) (if quantity)	Discriminator Code (SNOMED-CT)
Personal Value	1..1		31614008 (Personal Motivation)
Importance	1..1	IU	247752005 (Level of Interest)
Contentment	1..1	IU	406193000 (Client satisfaction)

3.4.4.7 Goal Resource Profile (Profiling FHIR Goal as base resource)

Data Element	Card.	Data Type	Description
Goal.subject	1..1	Reference	Reference to the patient whom this goal is about
Goal.startDate	1..1	date	Date when goal pursuit begins
Goal.targetQuantity	0..1	Duration	Reach goal on or before (ex: 3 months)
Goal.category	1..1	CodeableConcept	Category of the goal. (See Table 16).
Goal.description	1..1	string	Textual description of the goal
Goal.author	1..1	Reference	Reference to the record (Patient or Practitioner) to show who is responsible creating this goal.
Goal.status	1..1	code	Status of the goal (see Table 14)
Goal.priority	0..1	CodeableConcept	Priority of the goal from value set GoalPriority ²¹
Goal.outcome	0..*	BackboneElement	
Goal.outcome.resultReference	1..1	Reference	Reference to the Observation that describes the outcome of this goal (ex: observation of body weight). If the goal is short-term daily or weekly goal each outcome element refers to the Observation that evaluates for that day or week.
Goal.addresses	0..*	Reference(Problem) Reference(PersonalValue) Reference(Observation)	Reference to the Problem or PersonalValue that this goal is addressing OR Reference to an Observation that provides the starting point of patient for the goal's target measure
Goal.note	0..*	Backbone Element	All notes about a Goal (rewards, motivational messages, instructions)
Goal.note.noteType	1..1	POWER2DM_noteType	Extension to indicate the type of note (reward motivation)

²¹ <https://www.hl7.org/fhir/valueset-goal-priority.html>

Goal.note.text	1..1	string	The text describing the reward or motivation
Goal.meta	1..1	Meta	The metadata for the Resource
Goal.meta.tag	0..*	Coding	Tags assigned to this goal for further application level categorization.
FHIR Extensions			
Goal.goal-target	0..1	goal-target ²²	Extension to indicate the target parameter of goal
Goal.goal-target.measure	1..1	CodeableConcept	The parameter whose value is being tracked, e.g. body weight, blood pressure, or HbA1c. (See Table 14)
Goal.goal-target.detail	0..1	Quantity, Range, CodeableConcept	The target value range of the focus to be achieved to signify the fulfillment of the goal, e.g. 3kg weight loss, HbA1C below ..., etc.
Goal.goal-pertainsToGoal	0..*	goal-pertainsToGoal ²³	Extension to indicate the related goal
Goal.goal-pertainsToGoal.valueReference	1..1	Reference(Goal)	Reference to another Goal (probably longer term) to indicate that achieving this Goal can contribute to the target Goal

Table 13 POWER2DM Value set for Goal.status

Code	Meaning
in-progress	The goal is being sought but has not yet been reached.
achieved	The goal has been met and no further action is needed
not-achieved	The goal has not been met, at the end of the target duration
sustaining	The goal has been met, but ongoing activity is needed to sustain the goal objective
cancelled	The goal is no longer being sought

Table 14 POWER2DM Value set for Goal.targetMeasure

Meaning	Code	Code System
Related with Blood Glucose Management		
HbA1c (%)	4548-4	LOINC
QScore	qscore	POWER2DM
QScore MBG	qs-mbg	POWER2DM
QScore Range	qs-range	POWER2DM
QScore t-hyper	qs-thyper	POWER2DM
QScore t-hypo	qs-thypo	POWER2DM
QScore MODD	qs-modd	POWER2DM
Medication Adherence (number of compliant intakes/planned intakes) percentage	418633004	SNOMED
BG Monitoring Adherence (number of compliant monitoring/planned)	308113006	SNOMED
Related with Dietary Management		
Body Weight (kg)	29463-7	LOINC
Daily average bread unit intake (bu/d)	226394005	SNOMED
Daily average carb intake (g/d)	162535007	SNOMED

²² <https://www.hl7.org/fhir/extension-goal-target.html>

²³ <https://www.hl7.org/fhir/extension-goal-pertainstogoal.html>

Daily average calorie intake (kcal/d)	162533000	SNOMED
Daily average of fiber intake (g/d)	162520006	SNOMED
Daily average fatty acid intake (g/d)	226328000	SNOMED
Daily average of salt intake (g/d)	309544001	SNOMED
Daily average of vegetable intake (g/d)	226448008	SNOMED
Daily average of fruit intake (g/d)	226452008	SNOMED
Daily average of peas/beans intake (g/d)	226450000	SNOMED
Daily average of nuts intake (g/d)	226456006	SNOMED
Weekly average of alcohol consumption (portion/wk)	160573003	SNOMED
Related with Physical Activity		
Average moderate hours of physical activity per week (h/wk)	252130009	SNOMED
(Times x Minutes per time) strenuous physical activity per week (count.min/wk)	68130003	SNOMED
Related with Sleeping/Stress Management		
Average sleep quality score (/d)	248254009	SNOMED
Stress score (/d)	405052004	SNOMED
(Times x Minutes per time) stress reducing activities (yoga, meditation) per week (count.min/wk)	11609002	SNOMED
Average sleep time per day	248263006	SNOMED
Others		
DM-QOL score	405152002	SNOMED

Table 15 POWER2DM Value set for Goal.categories

Meaning	Code
Health Goal	health
Behavioral Goal (Health related)	behavioral

3.4.4.8 ActionPlan Resource Profile (Profiling FHIR ProcedureRequest as base resource)

FHIR Path	Card.	FHIR Data Type	Description
ProcedureRequest.subject	1..1	Reference (Patient)	Reference to the patient who has this planned action
ProcedureRequest.code	1..1	CodeableConcept	Identification of the planned action with a coded value (See Table 15)
ProcedureRequest.scheduled[x]	1..1	dateTime, Period or Timing	Provide the scheduling information for the planned action. See Section 3.5.6 for data types Timing and Period for alternatives.
ProcedureRequest.orderedOn	1..1	dateTime	Indicate the time this action plan record is created
ProcedureRequest.orderer	1..1	Reference (Patient), Reference (Practitioner)	Reference to either the corresponding Patient or Practitioner. Referring "Patient" means this a "Self-management Action Plan" and otherwise it means it is a

			"Treatment Action Plan" agreed on shared-decision making.
ProcedureRequest.status	1..1	code	Status of the planned action (in-progress completed)
ProcedureRequest.note	0..*	BackboneElement	All type of notes regarding this planned action (Tip, Motivational message, ...)
ProcedureRequest.note.noteType	1..1	code	The coded element showing the type of Note (tip motivation instruction)
ProcedureRequest.note.text	1..1	string	Text of the note
ProcedureRequest.meta	1..1	Meta	Metadata for the resource
ProcedureRequest.meta.tag	0..*	Coding	Tags assigned to this action plan for further application level categorization.
FHIR Extensions			
ProcedureRequest.relatedGoal	0..*	POWER2DM_relatedGoal	Extension to indicate the related goal with this action plan
ProcedureRequest.relatedGoal.valueReference	1..1	Reference (Goal)	Reference to "Goal" record to indicate that this planned action is related with the target goal and will help to reach it
ProcedureRequest.relatedBarrier	0..*	POWER2DM_relatedBarrier	Extension to indicate the related barrier with this action plan
ProcedureRequest.relatedBarrier.valueReference	1..1	Reference (Barrier)	Reference to "Barrier" record to indicate this planned action is to resolve that specific barrier
ProcedureRequest.relatedProblem	0..*	POWER2DM_relatedProblem	Extension to indicate the related problem with this action plan
ProcedureRequest.relatedProblem.valueReference	1..1	Reference (Problem)	Reference to "Problem" record to indicate this planned action is to resolve that specific problem
ProcedureRequest.actionDetail	0..*	POWER2DM_actionDetail	Extension to provide some numerical details for the planned action
ProcedureRequest.actionDetail.code	1..1	POWER2DM_actionDetail_code	Extension.extension
ProcedureRequest.actionDetail.code.valueCoding	1..1	Coding	The coded value indicating the detail regarding the planned activity (e.g. distance)
ProcedureRequest.actionDetail.value	1..1	POWER2DM_actionDetail_value	Extension.extension
ProcedureRequest.actionDetail.value.value[x]	1..1	Quantity CodedDescription	Provide numerical details for the planned activity (e.g. Run <u>5 km</u>)
ProcedureRequest.category	0..1	POWER2DM_actionCategory	Extension to indicate category of the planned action
ProcedureRequest.category.valueCode	1..1	code	The coded value indicating the category.

Table 16 POWER2DM Value set for ActionPlan.code

Meaning	Code	Code System
Related with Blood Glucose Management		
Measure Blood glucose	monitor_bgm	POWER2DM
Log insulin/medication intakes	log_medications	POWER2DM

Related with Dietary Management		
Log carbohydrates for meals	log_carbs	POWER2DM
Log dietary intake for meals (Food diary)	log_diet	POWER2DM
Measure your weight	monitor_weight	POWER2DM
Related with Physical Activity		
Use activity tracker device to monitor your activity (steps)	track_activity	POWER2DM
Log your exercises	log_exercise	POWER2DM

3.4.4.9 MedicationOrder Resource Profile (Profiling FHIR MedicationOrder as base resource)

FHIR Path	Card.	FHIR Data Type	Description
MedicationOrder.patient	1..1	Reference(Patient)	Reference to the patient whom this medication order is given
MedicationOrder.dateWritten	1..1	dateTime	Date this medication order is written
MedicationOrder.status	1..1	code	Status of the order (active completed stopped)
MedicationOrder.dateEnded	0..1	dateTime	Date when this medication order is no longer valid
MedicationOrder.prescriber	1..1	Reference(Practitioner)	Reference to "Practitioner" that provides this medication order
MedicationOrder.medicationCodeableConcept	1..1	CodeableConcept	Identifies the medication prescribed (See Table 17)
MedicationOrder.dosageInstruction	1..*	Backbone Element	Provide the details for the dosage of medication
MedicationOrder.dosageInstruction.timing	1..1	Timing	When medication should be administered (see FHIR Timing ²⁴ datatype)
MedicationOrder.dosageInstruction.doseQuantity	1..1	Quantity	Dose of insulin or medication to take
MedicationOrder.note	0..1	string	Further textual instructions for the medication intake

Table 17 POWER2DM Value set for Medications

Code	Meaning
acarbose	Acarbose
actoplus-met	Actoplus Met
actos	Actos
amaryl	Amaryl
diabeta	Diabeta
duetact	Duetact
fortamet	Fortamet
glucophage	Glucophage
glucophage-xr	Glucophage XR

²⁴ <https://www.hl7.org/fhir/datatypes.html#Timing>

glucotrol	Glucotrol
glucotrol-xl	Glucotrol XL
glucovance	Glucovance
glumetza	Glumetza
glynase	Glynase
glyset	Glyset
janumet	Janumet
januvia	Januvia
kombiglyze	Kombiglyze
micronase	Micronase
onglyza	Onglyza
prandimet	Prandimet
prandin	Prandin
riomet	Riomet
starlix	Starlix
tradjenta	Tradjenta
welchol	Welchol
apidra	Apidra
humalog	Humalog
injectables	Injectables
insulin-regula	Insulin Regula
insulin-nph	Insulin NPH
lantus	Lantus
levemir	Levemir
novolog	Novolog

3.4.4.10 Appointment Resource Profile (Profiling FHIR Appointment as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Appointment.status	1..1	code	Status of the appointment (see Table 18)
Appointment.type	1..1	CodeableConcept	Type of the planned encounter (See Table 19)
Appointment.start	1..1	instant	Time of the appointment
Appointment.minutesDuration	1..1	positiveInt	Duration of appointment in minutes
Appointment.participant[1]	1..1	BackboneElement	Details for patient participant
Appointment.participant[1].actor	1..1	Reference(Patient)	Reference to the patient who will participate to the appointment
Appointment.participant[1].status	1..1	code	Participation status of patient (accepted declined needs-action)
Appointment.participant[1].type	1..1	CodeableConcept	Use fixed code "PART" (code system: http://hl7.org/fhir/v3/ParticipationType)
Appointment.participant[2]	1..1	BackboneElement	Details of practitioner participant
Appointment.participant[2].actor	1..1	Reference (Practitioner)	Practitioner to participate to the appointment

Appointment.participant[2].status	1..1	code	Participation status of practitioner (accepted declined needs-action)
Appointment.participant[2].type	1..1	CodeableConcept	Use fixed code "PPRF" (code system: http://hl7.org/fhir/v3/ParticipationType)

Table 18 POWER2DM Value set for Appointment.status (using FHIR value Appointment-status value set²⁵)

Code	Meaning
proposed	None of the participant(s) have finalized their acceptance of the appointment request, and the start/end time may not be set yet.
pending	Some or all of the participant(s) have not finalized their acceptance of the appointment request.
booked	All participant(s) have been considered and the appointment is confirmed to go ahead at the date/times specified.
fulfilled	This appointment has completed and may have resulted in an encounter.
cancelled	The appointment has been cancelled.

3.4.4.11 Encounter Resource Profile (Profiling FHIR Encounter as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Encounter.patient	1..1	Reference(Patient)	The patient present at the encounter
Encounter.status	1..1	code	The status of encounter (in-progress finished)
Encounter.type	1..1	CodeableConcept	Type of this encounter (See Table 19)
Encounter.participant	1..1	BackboneElement	
Encounter.participant.individual	1..1	Reference (Practitioner)	Reference to the "Practitioner" that will involve in encounter
Encounter.appointment	0..1	Reference(Appointment)	Reference to the "Appointment" that schedule this encounter
Encounter.period	1..1	dateTime	The date of encounter (use start)

Table 19 POWER2DM Value set for Encounter.type

Meaning	Code
POWER2DM Initial Consultation	care-planning
POWER2DM Periodic Treatment Plan Review	periodic-review
Emergency Visit	emergency
POWER2DM Treatment Plan Review (Non-periodic)	review

3.4.5 FHIR Resource Profiles for POWER2DM Observations of Daily Life and Clinical Results Data Entities

3.4.5.1 POWER2DM Observation Resource Profile (Profiling FHIR Observation as base resource)

²⁵ <https://www.hl7.org/fhir/valueset-appointmentstatus.html>

FHIR Path	Card.	FHIR Data Type	Description
Observation.subject	1..1	Reference(Patient)	Reference to the patient who this observation is about
Observation.code	1..1	CodeableConcept	Type of observation identified by a coded value (See Table 20)
Observation.performer	0..1	Reference(Practitioner), Reference(Patient), Reference(Organization)	Reference to the person who is responsible for the observation. This can be a reference to "Patient" if patient make and report the observation. If observation is made and reported by care provider, reference should be given to corresponding "Practitioner" record. If observation is coming from an organization (e.g. Laboratory), reference should be given to corresponding "Organization" record.
Observation.effective[x]	1..1	Period, dateTime	Clinically relevant time or period for the observation
Observation.device	0..1	Reference(Device)	Reference to "Device" record which defines the device instance that makes this measurement
FHIR Extensions			
Observation.acknowledgedPlannedAction	0..*	POWER2DM_acknowledgedPlannedAction	Extension to provide the planned action that this observation is about
Observation.acknowledgedPlannedAction.valueReference	1..1	Reference(ActionPlan)	Reference to the planned activities that then are marked as "executed/done" or whatsoever.

Table 20 POWER2DM Value set for Observation.code

Meaning	Code	Code System
Observations during self-management		
CGM Result (for a period of time, session – blood glucose series)	412928005	SNOMED
Blood Glucose	41653-7 (mg/dL)	LOINC
Body Weight	3141-9 (kg)	LOINC
Waist Circumference	56115-9 (cm)	LOINC
Blood Pressure	75367002	SNOMED
Tracker Heart Rate Summary	hr-daily-summary	POWER2DM
Tracker Heart Rate Daily Time Series	hr-intraday-series	POWER2DM
Dietary Intake Log	364395008	SNOMED
Physical Activity Log	68130003	SNOMED
Activity Tracker Daily Summary	activity-daily-summary	POWER2DM
Sleep Tracker Sleep Summary	sleep-summary	POWER2DM
Sleep Quality VAS	sleep-vas	POWER2DM
State of Mind (Spire data)	162715009	SNOMED
Breath Rate (Spire Data)	86290005	SNOMED
Stress VAS	stress-vas	POWER2DM
Mood VAS	mood-vas	POWER2DM
Complaint	409586006	SNOMED
Acknowledgement	ack	POWER2DM
Clinical Results/Lab tests		
HbA1c	4548-4 (%)	LOINC
Body Height	8302-2 (cm)	LOINC
Smoking Status	72166-2	LOINC
Fasting Insulin	27873-9 (uIU/mL)	LOINC
Fasting Glucose	1558-6 (mg/dL)	LOINC
Insulin sensitivity (%HOMA-2 S)	homa2s	POWER2DM
Beta cell function (%HOMA-2-B)	homa2b	POWER2DM
Inflammation (hs-CRP)	30522-7 (mg/L)	LOINC
Total Cholesterol (TC)	2093-3 (mg/dL)	LOINC

HDL	2085-9 (mg/dL)	LOINC
LDL	18262-6 (mg/dL)	LOINC
Triglycerides	2571-8 (mg/dL)	LOINC
Cholesterol ratio	9830-1	LOINC
Albumin	1751-7 (g/dL)	LOINC
Creatinine	2160-0 (mg/dL)	LOINC
Cortisol	2143-6 (ug/dL)	LOINC
Glomerular Filtration Rate (GFR)	33914-3 (mL/min/{1.73_m2})	LOINC
Thyroglobulin (TG)	3013-0 (ng/dL)	LOINC
Alanine Aminotransferase (ALAT)	1742-6 (U/L)	LOINC
Aspartate Amino Transferase (ASAT)	1920-8 (U/L)	LOINC
SOD Activity	45333-2 (U/L)	LOINC
Vascular cell adhesion molecule 1 (VCAM1)	17103-3 (%)	LOINC
Intercellular Adhesion Molecule 1 (ICAM1)	17174-4 (%)	LOINC
Non-Estrefied Fatty Acids (NEFA)	15066-4 (mmol/L)	LOINC
Questionnaire or Evaluation Score		
DM-QOL Score (WHO-5)	q-who5	POWER2DM
Depression Score (PHQ-9)	q-phq9	POWER2DM
Anxiety Score (GAD7)	q-gad7	POWER2DM
Perceived Stress Score (PSS)	q-pss	POWER2DM
Life circumstances score (AS4)	q-as4	POWER2DM
Diabetes Distress Score (PAID)	q-paid	POWER2DM
Diabetes Self-Management Score (DSMQ-R)	q-dsmqr	POWER2DM
Diabetes related QoL Score (ADDQoL)	q-addqol	POWER2DM
Hypoglycemic related Distress-Behavior Score (HFS)	q-hfs	POWER2DM
Diabetes related eating problems score (DEPS-R)	q-depsr	POWER2DM
Hyperglycemia related distress score (FCQ)	q-fcq	POWER2DM
Fear of Injections and Self-Monitoring score (D-FISQ)	q-dfisq	POWER2DM
After-Scenario Questionnaire score (ASQ)	q-asq	POWER2DM
Gut Health Questionnaire score	q-gh	POWER2DM

3.4.5.1.1 Single Observation with Quantity Value Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Observation.effectiveDateTime	1..1	dateTime	Clinically relevant time for measurement
Observation.valueQuantity	1..1	Quantity	Measured value

3.4.5.1.2 Single Observation with Coded Value Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Observation.effectiveDateTime	1..1	dateTime	Clinically relevant time for measurement
Observation.valueCodeableConcept	1..1	CodeableConcept	Observation value identified by a coded value

Table 21 POWER2DM Value set for SmokingStatus.value (SNOMED-CT as base code system)

Meaning	Code
Non Smoker	8392000
Heavy Smoker (over 20 per day)	56771006
Moderate Smoker (less than 20 per day)	56578002
Light Smoker (less than 9 per day)	230060001

3.4.5.1.3 Time Series Observations Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Observation .effectivePeriod	1..1	Period	Clinically relevant time-period for time series observation
Observation .valueSampledData	1..1	SampleData	Periodic sensor measurements (See FHIR SampleData ²⁶ data type for possible representation)

3.4.5.1.4 Blood Pressure Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Type	Data	Description
Observation .effectiveDateTime	1..1	dateTime		Clinically relevant time for blood pressure measurement
Observation.component[0]	1..1			Provides the value for systolic blood pressure
Observation.component[0].code	1..1	CodeableConcept		Use fixed LOINC code “8480-6” to indicate that this is a systolic blood pressure
Observation.component[0].valueQuantity	1..1	Quantity		The value and unit of systolic blood pressure
Observation.component[1]	1..1			Provides the value for diastolic blood pressure
Observation.component[1].code	1..1	CodeableConcept		Use fixed LOINC code “8462-4” to indicate that this is a diastolic blood pressure
Observation.component[1].valueQuantity	1..1	Quantity		The value and unit of systolic blood pressure
Observation.component[2]	0..1			Provides the value for heart rate
Observation.component[2].code	1..1	CodeableConcept		Use fixed LOINC code “8867-4” to indicate that this is a heart rate
Observation.component[2].valueQuantity	1..1	Quantity		The value and unit for heart rate observation done at the same time if any

3.4.5.1.5 Tracker Heart Rate Summary Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Observation .effectiveDateTime	1..1	dateTime	Date of the heart rate summary report
Observation.component[0]	1..1		Provides the Resting Heart rate
Observation.component[0].code	1..1	CodeableConcept	Use fixed LOINC code “40443-4” to indicate this component provides the resting heart rate
Observation.component[0].valueQuantity	1..1	quantity	The value of resting heart rate
...			See list of all components from Table 22

Table 22 List of components in Tracker Heart Rate Summary

Components	Card.	Units (UCUM)	Discriminator Code
Resting Heart Rate	1..1	beats/min	“40443-4” Heart Rate-Resting (LOINC)

²⁶ <https://www.hl7.org/fhir/datatypes.html#SampledData>

Peak Zone Maximum Heart Rate	1..1	beats/min	peak-max (POWER2DM)
Peak Zone Minimum Heart Rate	1..1	beats/min	peak-min (POWER2DM)
Peak Zone Duration	1..1	min	peak-duration (POWER2DM)
Peak Zone Calorie	1..1	kcal	peak-calorie (POWER2DM)
Cardio Zone Maximum Heart Rate	1..1	beats/min	cardio-max (POWER2DM)
Cardio Zone Minimum Heart Rate	1..1	beats/min	cardio-min (POWER2DM)
Cardio Zone Duration	1..1	min	cardio-duration (POWER2DM)
Cardio Zone Calorie	1..1	kcal	cardio-calorie (POWER2DM)
Fat Burn Zone Maximum Heart Rate	1..1	beats/min	fatburn-max (POWER2DM)
Fat Burn Zone Minimum Heart Rate	1..1	beats/min	fatburn -min (POWER2DM)
Fat Burn Zone Duration	1..1	min	fatburn-duration (POWER2DM)
Fat Burn Zone Calorie	1..1	kcal	fatburn-calorie (POWER2DM)
Out of Zone Maximum Heart Rate	1..1	beats/min	out-max (POWER2DM)
Out of Zone Minimum Heart Rate	1..1	beats/min	out-min (POWER2DM)
Out of Zone Duration	1..1	min	out-duration (POWER2DM)
Out of Zone Calorie	1..1	kcal	out-calorie (POWER2DM)

3.4.5.1.6 Dietary Intake Log Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Type	Data	Description
Observation.effectiveDateTime	1..1	dateTime		Time of consumption (dietary intake)
Observation.component[0]	1..1			Provides the Bread Unit (BU) correspondence of dietary intake
Observation.component[0].code	1..1	CodeableConcept		Use fixed SNOMED-CT code “226394005” (Bread Intake) to indicate that this component provides the corresponding BU amount consumed
Observation.component[0].valueQuantity	1..1	Quantity		Corresponding BU amount
...				See Table 23 for all components

Table 23 List of components in Dietary Intake resource

Components	Card.	Units (UCUM)	Discriminator Code (From SNOMED-CT)
Bread Unit amount	0..1	BU	“226394005” Bread Intake
Carbohydrate amount	1..1	g	“162535007” Dietary Carbohydrate Intake
Calorie amount	0..1	cal	“162533000” Dietary Calorie Intake
Saturated fatty acid amount	0..1	g	“226328000” Saturated Fat Intake
Fiber intake amount	0..1	g	“162520006” Dietary Fiber Intake
Salt intake amount	0..1	g	“309544001” Dietary Salt Intake
Vegetable intake amount	0..1	g	“226448008” Vegetable Intake
Fruit intake amount	0..1	g	“226452008” Fruit Intake
Peas/Beans intake amount	0..1	g	“226450000” Pulse vegetable intake
Nuts/seeds intake amount	0..1	g	“226456006” Nuts and seeds intake

3.4.5.1.7 Physical Activity Log Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Observation.effectiveDateTime	1..1	dateTime	Start time of physical activity logged
Observation.component[0]	1..1		Type of physical activity
Observation.component[0].code	1..1	CodeableConcept	Use fixed SNOMED-CT code “68130003” (Physical Activity) to indicate this component provides the type of physical activity performed
Observation.component[0].valueCodeableConcept	1..1	CodeableConcept	Identify the physical activity type by a coded value (Fitbit Activity list will be used)

...			See Table 24 for all components
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Table 24 List of components in Physical Activity Log resource

Components	Card.	Value Type	Discriminator Code
Activity Type	1..1	CodeableConcept (See Error! Reference source not found.)	"68130003" Physical Activity (SNOMED)
Activity Duration	1..1	Quantity (minutes)	"252130009" Total Exercise Time (SNOMED)
Distance	0..1	Quantity (meters)	"246132006" Distance (SNOMED)
Calories Burned	0..1	Quantity (kcal)	"41981-2" Calories Burned (LOINC)
Activity Intensity (MET Score)	0..1	Quantity (MET)	"698834005" Metabolic Equivalent of Task (SNOMED)
Steps (only for walking and running)	0..1	Quantity (step)	"55423-8" Step Count (LOINC)

3.4.5.1.8 Activity Tracker Daily Summary Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Type	Data	Description
Observation.effectiveDateTime	1..1	dateTime		The date the summary is collected
Observation.component[0]	1..1			Total distance for the day
Observation.component[0].code	1..1	CodeableConcept		Use fixed SNOMED-CT code "246132006" (Distance) to indicate this component provides the distance
Observation.component[0].valueCodeableConcept	1..1	Quantity		The distance value
...				See Table 25 for all components

Table 25 List of components in Activity Tracker Daily Summary

Components	Card.	Value Type	Discriminator Code
Total distance	1..1	Quantity (meters)	"246132006" Distance (SNOMED)
Total calories burned	1..1	Quantity (kcal)	"41981-2" Calories Burned (LOINC)
Total steps	1..1	Quantity (step)	"55423-8" Step Count (LOINC)
Total sedentary minutes	0..1	Quantity (min)	"total-sedentary-minutes" (POWER2DM)
Total lightly active minutes	0..1	Quantity (min)	"total-lightly-active-minutes" (POWER2DM)
Total moderately active minutes	0..1	Quantity (min)	"total-moderately-active-minutes" (POWER2DM)
Total very active minutes	0..1	Quantity (min)	"total-very-active-minutes" (POWER2DM)
Intraday time series for distance (e.g. 15 min intervals)	0..1	SampledData (meters)	"intraday-ts-distance" (POWER2DM)
Intraday time series for steps	0..1	SampledData (step)	"intraday-ts-steps" (POWER2DM)
Intraday time series for calories burned	0..1	SampledData (kcal)	"intraday-ts-calories" (POWER2DM)

3.4.5.1.9 Sleep Tracker Sleep Summary Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Type	Data	Description
Observation.effectiveDateTime	1..1	dateTime		The datetime the sleep is started
Observation.component[0]	1..1			Total distance for the day

Observation.component[0].code	1..1	CodeableConcept	Use fixed SNOMED-CT code "248263006" (Duration of Sleep) to indicate this component provides the duration of sleep
Observation.component[0].valueCodeableConcept	1..1	Quantity	The distance value
...			

Table 26 List of components in Sleep Tracker Sleep Summary

Components	Card.	Value Type	Discriminator Code
Sleep Duration	1..1	Quantity (min)	"248263006" Duration of Sleep (SNOMED)
Minutes to fall asleep	0..1	Quantity (min)	"minutes-fall-asleep" (POWER2DM)
Sleep efficiency	0..1	Quantity	"248254009" (SNOMED)
Number of Awaken times	0..1	Quantity	"awaken-times" (POWER2DM)
Number of Restless times	0..1	Quantity	"restless-times" (POWER2DM)

3.4.5.1.10 Mind State Resource Profile (Profiling POWER2DM Observation as base resource)

This record will contain the data produced by Spire.io for a observation of state of mind for a specific time period.

FHIR Path	Card.	FHIR Type	Data	Description
Observation.effectivePeriod	1..1	Period		Start and end times of the observation of State of Mind
Observation.code	1..1	CodeableConcept		Use fixed SNOMED code "162715009" to indicate this is an state-of-mind observation
Observation.component[0]	1..1			The state-of-mind observed
Observation.component[0].code	1..1	CodeableConcept		Use fixed SNOMED-CT code "162715009" (State of mind) to indicate this component provides the observation of state of mind
Observation.component[0].valueCodeableConcept	1..1	CodeableConcept		Value indicating the state of mind (focus tense calm)
...				

Components	Card.	Value Type	Discriminator Code
State of mind (Patient's Input)	0..1	Code (focus tense calm)	"mind-state" (POWER2DM)
State of Mind (Device detected)	1..1	Code (focus tense calm)	"mind-state-original" (POWER2DM)
Duration	0..1	Quantity (sec)	"duration" (POWER2DM)
Average Breath Rate	0..1	Quantity (/minute)	"br" (POWER2DM)
Is patient approve the observation	0..1	boolean	"correct" (POWER2DM)

3.4.5.1.11 Questionnaire Result Resource Profile (Profiling POWER2DM Observation as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Observation.effectiveDateTime	1..1	dateTime	The time that the action is performed.
Observation.valueQuantity	1..1	quantity	The value of the total score from the questionnaire

Observation.related	1..1	BackboneElement	
Observation.related.target	1..1	Reference (QuestionnaireResponse)	Reference to the "QuestionnaireResponse" record that contains the responses of the patient to questionnaire
Observation.interpretation	0..1	CodeableConcept	Interpretation of the score (e.g. high, low, etc) See ²⁷

3.4.5.2 Acknowledgement Resource Profile (Profiling POWER2DM Procedure as base resource)

Observation resources in general are the acknowledgements of planned actions e.g. Action Plan: Monitor your blood glucose → Blood glucose measurement. In other words, by looking at the observation you can understand that the planned action is done. This resource is for all other actions that does not correspond to a defined observation to acknowledge that action is done.

FHIR Path	Card.	FHIR Data Type	Description
Procedure.subject	1..1	Reference(Patient)	Reference to the patient who is related with this procedure
Procedure.status	1..1	code	Use fixed code "completed"
Procedure.code	1..1	CodeableConcept	Code to identify the action done (See Table 16)
Procedure.performedDateTime	0..1	dateTime	Time that this action is done
Procedure.request	1..1	Reference(ActionPlan)	Reference to the action plan that plans the acknowledged action

3.4.5.3 POWER2DM Risk Assessment Resource Profile (Profiling FHIR RiskAssessment²⁸ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
RiskAssesment.subject	1..1	Reference(Patient)	Reference to the patient who this risk assessment is about
RiskAssesment.date	1..1	dateTime	Date assessment is done
RiskAssesment.performer	1..1	Reference(Patient) Reference(Practitioner) Reference(Device)	Reference to "Practitioner", "Patient" or "Device" (POWER2DM system) who runs the risk score model for this assessment
RiskAssesment.method	1..1	CodeableConcept	The coded value describing the risk assessment model and methodology (See Table 26)
RiskAssesment.prediction	1..*	BackboneElement	The prediction results
RiskAssesment.prediction.outcome	1..1	CodeableConcept	Coded value describing the calculated outcome (See Table 28)
RiskAssesment.prediction.probability[x]	1..1	decimal Range	The risk score giving the probability or the range of risk score (showing the margin of error)
RiskAssesment.prediction.relativeRisk	0..1	decimal	Indicates the risk for this particular subject (with their specific characteristics) divided by the risk of the population in general.

²⁷ <https://www.hl7.org/fhir/valueset-observation-interpretation.html>

²⁸ <https://www.hl7.org/fhir/riskassessment.html>

RiskAssesment.prediction.whenRange	0..1	Range	Timeframe in terms of years that this prediction is about (e.g risk of CVD in <u>10 years</u>)
RiskAssesment.basis	1..1	Reference (SimulationParameters)	Reference to Parameters ²⁹ resource that list all the input parameters used for the calculation. Reference will be contained in the resource.
RiskAssesment.meta.tag	1..1	Coding	Coded value describing the purpose of assessment. (See Table 30)

Table 27 POWER2DM Value set for RiskAssesment.method

Meaning	Code
UKDPS Risk Engine	ukpds
ADVANCE Cardiovascular Risk Engine	advance-card
ADVANCE Kidney Risk Engine	advance-kidney
T1D Major Outcomes	mot1d

Table 28 POWER2DM Value set for RiskAssesment.prediction.outcome

Meaning	Code
CHD	chd-risk
Fatal CHD	fatal-chd-risk
Stroke	stroke-risk
Fatal Stroke	fatal-stroke-risk
Major cardiovascular risk	major-card-risk
New onset albuminuria	albuminuria-risk
Major kidney related event	major-kidney-risk
Total Major Outcomes	major-outcomes-risk

3.4.5.4 POWER2DM Prediction Result Resource Profile (Profiling FHIR RiskAssessment²⁸ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
RiskAssesment.subject	1..1	Reference(Patient)	Reference to the patient who this prediction is about
RiskAssesment.date	1..1	dateTime	Date assessment is done
RiskAssesment.performer	1..1	Reference(Patient) Reference(Practitioner) Reference(Device)	Reference to "Practitioner", "Patient" or "Device" (POWER2DM system) who runs the prediction/simulation
RiskAssesment.method	1..1	CodeableConcept	The coded value describing prediction model. (See Table 29)
RiskAssesment.prediction	1..*	BackboneElement	Element providing prediction result for one of the predicted parameter (BMI, Fasting Insulin, etc)
RiskAssesment.prediction.outcome	1..1	CodeableConcept	Coded value describing the predicted parameter (See Table 31)
RiskAssesment.basis	0..1	Reference (SimulationParameters)	Reference to Parameters ³⁰ resource that list all the input parameters used for the calculation. Reference will be contained in the resource.
RiskAssesment.meta.tag	1..1	Coding	Coded value describing the purpose of assessment. (See Table 30)
FHIR extensions			
RiskAssesment.prediction.result	1..1	POWER2DM_predictedTimeSeries	Extension to provide the prediction results

²⁹ <https://www.hl7.org/fhir/parameters.html>

³⁰ <https://www.hl7.org/fhir/parameters.html>

RiskAssesment.prediction .result .valueSampledData	1..1	SampledData	Prediction results in time series format
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Table 29 POWER2DM Value set for PredictionResult.method

Meaning	Code
MARVEL	marvel
KADIS	kadis

Table 30 POWER2DM Value set for Motivation for Predictions

Meaning	Code
Prediction (with actual data to understand how the parameter will change in time)	prediction
Treatment Plan Simulation (what if patient adheres to his/her treatment plan and reaches his/her goals)	simulation-treatment-plan
Scenario Simulations (all intermediate scenario simulations done)	simulation

Table 31 POWER2DM Value set for Prediction Outcomes

Meaning	Code	Code System
MARVEL Predicted Parameters		
BMI	60621009	SNOMED
Fasting Insulin	27873-9 (u[IU]/mL)	LOINC
Fasting Glucose	1558-6 (mg/dL)	LOINC
Insulin Sensitivity	homa2s	POWER2DM
Beta cell function	homa2b	POWER2DM
Inflammation	30522-7 (mg/L)	LOINC
Tissue damage		
Gut Health		
Chronic stress levels		
Peripheral energy overload		
KADIS Predicted Parameters		
Blood Glucose Levels and BG Profiles	412928005	SNOMED
QScore	qscore	POWER2DM
QScore Mean Blood Glucose (MBG)	qs-mbg	POWER2DM
QScore Range	qs-range	POWER2DM
QScore t-hyper	qs-thyper	POWER2DM
QScore t-hypo	qs-thypo	POWER2DM
A1c* (calculated from the MBG of the calculated/simulated glucose profile)	4548-4 (%)	LOINC

3.4.5.5 POWER2DM Questionnaire Response Resource Profile (Profiling FHIR QuestionnaireResponse³¹ as base resource)

FHIR Path	Card.	FHIR Type	Data	Description
QuestionnaireResponse.subject	1..1	Reference (Patient)		Reference to the patient who this questionnaire is about
QuestionnaireResponse.questionnaire	1..1	Reference (Questionnaire)		Reference to the "Questionnaire" record where the questions are defined
QuestionnaireResponse.authored	1..1	dateTime		Date this questionnaire is filled

³¹ <https://www.hl7.org/fhir/questionnaireresponse.html>

QuestionnaireResponse.status	1..1	code	Use fixed code “completed”
QuestionnaireResponse.group	1..1	BackboneElement	Grouped questions (the root group). Groups may either contain questions or groups but not both
QuestionnaireResponse.group.linkId	1..1	string	Corresponding group within questionnaire
QuestionnaireResponse.group.question	0..*	BackboneElement	Component that contains the answer to a question
QuestionnaireResponse.group.question.linkId	1..1	string	Corresponding question within group
QuestionnaireResponse.group.question.answer	0..*	Backbone Element	Answer to the question
QuestionnaireResponse.group.question.answer.value[x]	1..1	* (See the base profile)	
QuestionnaireResponse.group.group	0..*	BackboneElement	Nested questionnaire response group

3.4.5.6 POWER2DM Medication Administration Resource Profile (Profiling FHIR MedicationAdministration³² as base resource)

FHIR Path	Card.	FHIR Data Type	Description
MedicationAdministration.patient	1..1	Reference (Patient)	Reference to the patient who this Medication administration is about
MedicationAdministration.prescription	0..1	Reference (MedicationOrder)	Reference to “MedicationOrder” record providing the medication instructions that this intake is about
MedicationAdministration.status	1..1	code	Use fixed code “completed”
MedicationAdministration.effectiveTimeDateTime	1..1	dateTime	Time medication is taken
MedicationAdministration.medicationCodeableConcept	1..1	CodeableConcept	Identifies the medication taken by a coded value (See Table 17)
MedicationAdministration.dosage.quantity	1..1	SimpleQuantity	Medication dose taken

3.4.5.7 POWER2DM Applied Intervention Resource Profile (Profiling FHIR Procedure as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Communication.subject	1..1	Reference (Patient)	Reference to the patient that the intervention is applied
Communication.category	1..1	CodeableConcept	Category of the intervention
Communication.payload	0..*	BackboneElement	Intervention details
Communication.payload.contentString	1..1	string	Identifier or content of the intervention
Communication.status	1..1	code	in-progress completed rejected
Communication.sent	1..1	dateTime	Time that this intervention is sent
Communication.received	0..1	dateTime	Time that the intervention is received or completed

³² <https://www.hl7.org/fhir/medicationadministration.html>

Communication.reason	0..1	CodeableConcept	Reason for communication (See Table 32)
Communication.requestDetail	0..1	Reference (CommunicationPreference)	Reference to the preference that this communication is about

Table 32 Value set for **AppliedIntervention.reason**

Code	Meaning
goal_achieved_more	Goal is achieved with positive surplus
goal_achieved	Goal achieved
goal_almost_achieved	Goal nearly achieved
goal_not_achieved	Goal not achieved

3.4.5.8 POWER2DM KADIS Baseline Dataset Resource Profile (Profiling FHIR Composition as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Composition.date	1..1	dateTime	Date this record is registered to the system and ready
Composition.type	1..1	CodeableConcept	Use fixed "pdm-kadis-basis" as the code to indicate the type of this record
Composition.title	1..1	string	Use "POWER2DM KADIS Baseline Dataset"
Composition.status	1..1	code	Use fixed "final" as the code to indicate the status of the report
Composition.subject	1..1	Reference(Patient)	Reference to the patient this report is about
Composition.author	1..1	Reference(Device)	Reference to the POWER2DM SMSS system
Composition.event	1..1	BackboneElement	
Composition.event.period	1..1	Period	The period covering the 3-day data collection period for KADIS
Composition.section[1]	1..1	BackboneElement	The section including the Blood Glucose Measurements
Composition.section[1].title	1..1	string	Use "Blood Glucose Measurements"
Composition.section[1].entry	0..*	Reference(Observation)	Reference to the observation records that provide the blood glucose measurements (either CGM or fingerprick measurements)
Composition.section[2]	1..1	BackboneElement	The section including the records for dietary intakes
Composition.section[2].title	1..1	string	Use "Dietary Intakes"
Composition.section[2].entry	0..*	Reference (DietaryIntakeLog)	Reference to the dietary intake log resources providing information about dietary intakes of patient
Composition.section[3]	1..1	BackboneElement	The section including the records for medication/insulin intakes
Composition.section[3].title	1..1	string	Use "Medication/Insulin Intakes"
Composition.section[3].entry	0..*	Reference (MedicationAdministration)	Reference to the medication administration records that provide the timing and dosage of medication/insulin intakes of patient
Composition.section[4]	1..1	BackboneElement	The section including the records for exercises
Composition.section[4].title	1..1	string	Use "Exercises"
Composition.section[4].entry	0..*	Reference (PhysicalActivityLog)	Reference to the physical activity log records providing information about exercises done by patient

3.4.5.9 POWER2DM KADIS Fingerprint Order Resource Profile (Profiling FHIR Order³³ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Order.date	1..1	dateTime	When this KADIS Fingerprint Identification order is sent to the KADIS
Order.subject	1..1	Reference(Patient)	Reference to the patient that this order is about
Order.source	1..1	Reference (Practitioner)	Who request this order
Order.target	1..1	Reference (Organization)	Reference to the IDK that will do the KADIS Fingerprint Identification
Order.when	1..1	BackboneElement	
Order.when .schedule	1..1	Timing	Use "Timing.event" to specify actual date which shows at which date the KADIS Fingerprint is requested to be ready
Order.detail	1..1	Reference (KADISBaselineDataset)	Reference to the baseline data set document that includes all the KADIS baseline data for this Fingerprint identification order

3.4.5.10 POWER2DM KADIS Fingerprint Order Response Resource Profile (Profiling FHIR Order Response³⁴ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
OrderResponse.request	1..1	Reference (KADISFingerprint Order)	Reference to the Order resource that this response is about
OrderResponse.date	1..1	dateTime	Date that KADISFingerprint is ready
OrderResponse.who	1..1	Reference (Organization)	Reference to Organization who performs the KADIS Fingerprint Identification process
OrderResponse .orderStatus	1..1	code	Use "completed" status to indicate Fingerprint is ready (no other status is required according to POWER2DM scenario for now)
OrderResponse .fullfilment	1..1	Reference (PredictionResult)	Reference to the PredictionResult resource that provides the characteristic Blood Glucose Profile calculated from baseline data

3.4.5.11 POWER2DM Communication Preferences Resource Profile (Profiling FHIR CommunicationRequest³⁵ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
CommunicationRequest .subject	1..1	Reference (Patient)	Patient that will receive the reminder/motivation
CommunicationRequest .receipient	1..*	Reference(Patient), Reference(Practitioner), Reference(RelatedPerson)	The receipient of communication

³³ <https://www.hl7.org/fhir/order.html>

³⁴ <https://www.hl7.org/fhir/orderresponse.html>

³⁵ <https://www.hl7.org/fhir/communicationrequest.html>

CommunicationRequest .category	1..1	CodeableConcept	Type of intervention e.g. motivational message, standard reminder (See Table 33)
CommunicationRequest .requester	1..1	Reference(Patient), Reference(Practitioner)	Who set this reminder/motivation
CommunicationRequest .scheduledPeriod	1..1	Period	Period that this reminder/motivation is valid (start is mandatory)
CommunicationRequest .status	1..1	code	Use "planned" or "completed"
CommunicationRequest .priority	1..1	CodeableConcept	Priority assigned to this reminder. See Table 34
FHIR Extensions			
CommunicationRequest .addresses	1..1	POWER2DM-CommunicationPreference -addresses	
CommunicationRequest .addresses .valueReference	1..1	Reference(Goal), Reference(ActionPlan), Reference(MedicationOrder) , Reference(Appointment)	Reference to the resource that this reminder/motivation/warning setting is about

Table 33 Value set for CommunicationPreferences.category

Code	Meaning
motivation	Motivational messages to support the patient to reach a goal
reminder	Reminder messages to remind patient for planned actions
instruction	Clinical warnings and instructions to handle specific cases
barrier_resolution	Messages to initiate barrier identification, propose help for barrier, offer intervention for barrier
evaluation	Standart evaluation of performance

Table 34 Value set for CommunicationPreferences.priority

Code	Meaning
mandatory	Communication will be done for each case
highly_preferred	
preferred	
acceptable	
not_preferred	
never	Communication will never be done

3.4.5.12 POWER2DM User Settings Resource Profile (Profiling FHIR Basic³⁶ as base resource)

FHIR Path	Card.	FHIR Data Type	Description
Basic.code	1..1	CodeableConcept	The code for UserSettings group.
Basic.subject	1..1	Reference(Patient), Reference(Practitioner)	Reference to the owner of settings
FHIR Extensions			
Basic.param	1..*	POWER2DM-Settings- param	Extension for settings parameters

³⁶ <https://www.hl7.org/fhir/basic.html>

Basic.param.name	1..1	string	Name of the parameter
Basic.param.value[x]	1..*	*	Value(s) of the parameter

3.4.6 POWER2DM extensions/restrictions for FHIR Data Types

3.4.6.1 CodeableConcept

FHIR Path	Card.	FHIR Data Type	Description
coding	0..1	Coding	If the value can be coded, use this element.
coding.system	1..1	uri	The code system identifier. See ³⁷ to check the URIs for common code systems. For POWER2DM code system use "http://www.power2dm.eu"
coding.code	1..1	code	The string representing the code
coding.display	1..1	string	The meaning of the code to display to the users
text	0..1	string	If the value cannot be coded, use this element to provide the textual description. The text element can only be used in some context, refer to the resource definitions.

3.4.6.2 Quantity

FHIR Path	Card.	FHIR Data Type	Description
value	1..1	decimal	Numerical value (with implicit precision)
unit	1..1	string	The representation of unit. All units in POWER2DM should be from UCUM ³⁸ .

3.4.6.3 Reference

FHIR Path	Card.	FHIR Data Type	Description
reference	1..1	string	Relative reference to the record (e.g. Patient/125588)

3.4.6.4 Period

FHIR Path	Card.	FHIR Data Type	Description
start	1..1	dateTime	Starting date time of the period
end	0..1	dateTime	End time for the period

3.4.6.5 Timing

FHIR Path	Card.	FHIR Data Type	Description
event	0..*	dateTime	The exact date times of the planned action, can set multiple times. Either use this element or use the repeat element.
repeat	0..1	Element	When the event is to occur
repeat.duration	0..1	decimal	Duration for the planned action in minutes (e.g. 90 minutes of running)
repeat.durationUnits	0..1	code	Use "min"
Alternative 1 - When the time within a day/week is not important for the planned action e.g. Have the cholesterol test each month (frequency: 1, period: 1, periodUnits: mo) e.g. Measure your weight every three days (frequency: 1, period: 3, periodUnits: d)			

³⁷ <https://www.hl7.org/fhir/terminologies-systems.html>

³⁸ <http://unitsofmeasure.org/trac>

e.g. Measure your blood pressure two times a day (frequency: 2, period: 1, periodUnits: d)			
repeat.frequency	0..1	integer	Event occurs frequency times per period
repeat.period	0..1	integer	Event occurs frequency times per period
repeat.periodUnits	0..1	code	Use the UCUM units (d wk mo a) to indicate the (day, week, month, annual)
Alternative 2 - When the time within a day/week is important for the planned action			
e.g. Run at Monday, Wednesday, Sunday before sleeping			
e.g. Have your breakfast around 9:00 every day			
e.g. Measure your blood glucose every day after meals			
FHIR Extensions			
repeat.time.dayOfWeek	0..*	code	The code identifies the day that this event occurs (monday tuesday wednesday thursday friday saturday sunday). If not exist, it means every day.
repeat.time.timeOfDay	0..*	Extension (timeOfDay)	
repeat.time.timeOfDay.when	1..1	time code Period	The time that the event is scheduled (e.g. at 10:55) or a period (e.g. between 10:00 and 10:30) or common life event (See the event-timing value-set[11]).
repeat.time.timeOfDay.offset	0..1	integer	Duration offset in minutes from the life event (e.g. 30 min before breakfast)

4 POWER2DM DATA SERVICE API

POWER2DM Data Service will be implemented as a “Restful FHIR”, in other words it will conform to FHIR specifications with further restrictions and narrowed scope. The following sections will describe the details for the Restful API. You can read FHIR Restful API specifications from the ³⁹.

4.1 Overview of Service Operations

In Restful frameworks, the operations on the resources are performed by using HTTP request/response. In FHIR the operations on the resources are defined as interactions. POWER2DM PDS will support the following FHIR interactions to access or manipulate resources;

- **read:** Read the content of a specific POWER2DM resource
- **update:** Update an existing resource by its id
- **delete:** Delete a specific resource
- **create:** Create a new resource
- **search:** Search among specific resource type of a patient based on some filter criteria
- **batch/transaction:** Update, create or delete a set of resources in a single interaction

The root URL (mentioned as [base] in the following sections) for the PDS service will be as follows;

- <https://www.power2dm.eu/pds>

The PDS will only support “**application/json+fhir**” (JSON) as MIME-type for FHIR resources. In other words, the data exchange will be only in JSON format.

The PDS will assign a unique identifier for each resource instance which is the LogicalId (.id attribute of resources) mentioned in FHIR. This id will be in UUID format and randomly generated.

For security, the communication will be protected by SSL (HTTPS) and for authorization for each operation the client should include the OAuth access token (OAuth Bearer profile) that includes the permissions given to the client for the specific patient.

³⁹ <https://www.hl7.org/fhir/http.html>

By following the FHIR methodology, the interactions are defined as follows and meaning of these are described below;

VERB [base]/[type]/[id] {?parameters}

- The first word is the HTTP verb used for the interaction
- Content surrounded by [] is mandatory, and will be replaced by the string literal identified.
Possible insertion values:
 - base: The Service Root URL
 - type: The name of a resource type (e.g. "Patient")
 - id: The Logical Id of a resource
 - compartment: The name of a compartment
 - parameters: URL parameters as defined for the particular interaction
- Content surrounded by {} is optional

4.2 Patient Identification Issues

As described in the deliverable “D4.9 Privacy and Security Enablers for POWER2DM Services I”, in POWER2DM two separate patient identifiers are used to identify patients. The Public Identifier for Patient (PIP) is managed by POWER2DM Core Services component. The other one Pseudonymous Identifier for Patient (PSIP) is managed by PDS.

The PDS will assign PSIP, a unique identifier, for each patient during the patient registration. The POWER2DM Core Services component will use the **create** service for the Patient resource to initiate this operation (no other system is authorised to create a Patient resource in PDS) and it will map the PSIP to PIP, maintain this mapping internally and does not share this mapping with anyone. In other words, PDS uses the PSIP as the [id] element for Patient resource.

4.3 Authorization Details

PDS conforms to OAuth Bearer Token Profile⁴⁰ for the authorization of API calls. The details of obtaining the access token from POWER2DM Core Services is described in D4.9. The access token is an encoded JSON Web Token (JWT) including the authorization information that PDS needs. The following is an example HTTP request for PDS;

```
GET /pds/Observation/1d04aa6c-ad23-4c12-a784-ad77d2b88320 HTTP/1.1
Host: www.power2dm.eu
Authorization: Bearer mF_9.B5f-4.1JqM...
```

4.4 Details of CRUD Operations

4.4.1 Read Operation

This operation will be implemented as described in the base FHIR specification. The read interaction accesses the current contents of a resource. The interaction is performed by an HTTP GET command as shown:

GET [base]/[type]/[id]

This operation returns a single instance with the content specified for the resource type. PDS will also return an ETag header with the versionId of the resource and a Last-Modified header showing the modification time of the resource.

⁴⁰ <https://tools.ietf.org/html/rfc6750>

The followings are some examples;

To get the Observation resource with the given identifier;

GET https://www.power2dm.eu/pds/Observation/1d04aa6c-ad23-4c12-a784-ad77d2b88320

To get the Goal resource with the given identifier;

GET https://www.power2dm.eu/pds/Goal/5b3e7a82-7263-44da-8459-9d57321ef56b

4.4.2 Update Operation

This operation will be implemented as described in the base FHIR specification with slight changes. In POWER2DM, the update interaction is only used for creating a new current version for an existing resource. The client is not allowed to assign an identifier to the resource and use the update operation to create the resource with this identifier. If this is done, (if the resource does not exist), HTTP 405 error will be returned.

The update interaction is performed by an HTTP PUT command as shown:

PUT [base]/[type]/[id]

The request body SHALL be a Resource with an id (.id) element that has an identical value to the [id] in the URL.

The following is an example update operation that updates an existing Goal resource;

PUT https://www.power2dm.eu/pds/Goal/5b3e7a82-7263-44da-8459-9d57321ef56b

```
{
  "resourceType": "Goal",
  "id": "5b3e7a82-7263-44da-8459-9d57321ef56b",
  ....
}
```

If the interaction is successful, the PDS will return a 200 OK HTTP status code with a Last-Modified header, and an ETag header which contains the new versionId of the resource. The following table shows the other Http status codes when the operation is failed/rejected;

Http Status Code	Meaning
400 Bad Request	Resource could not be parsed or failed basic FHIR validation rules
403 Not Authorized	Authorization is required for the interaction that was attempted, either the OAuth access token is missing or not valid, or user is not authorized for the operation
404 Not Found	Resource type not supported
405 Method Not allowed	The resource did not exist prior to the update or it is not allowed to update the instances of the given resource type as a general policy (e.g. device measurement).
422 Unprocessable Entity	The proposed resource violated applicable POWER2DM Resource Profiles

PDS will not support the conditional update operation.

If the client wishes to request a version aware update, it submits the request with an If-Match header that quotes the ETag from the server:

e.g. PUT /Patient/347 HTTP/1.1
If-Match: W/"23"

If the version id given in the If-Match header does not match, the server returns a 409 Conflict status code instead of updating the resource.

4.4.3 Delete Operation

The delete interaction removes an existing resource. The interaction is performed by an HTTP DELETE command as shown:

DELETE [base]/[type]/[id]

The PDS return 204 No Content to indicate that the resource is no longer found through search interactions or if the resource does not exist at all.

The following table shows the other Http status codes when the operation is failed/rejected;

Http Status Code	Meaning
405 Method Not allowed	It is not allowed to delete the instances of the given resource type as a general policy.
409 Conflict	If that resource cannot be deleted because of reasons specific to that resource, such as referential integrity
403 Not Authorized	Authorization is required for the interaction that was attempted, either the OAuth access token is missing or not valid, or user is not authorized for the operation

PDS will not support the conditional delete operation.

4.4.4 Create Operation

The create interaction creates a new resource in a server-assigned location. The create interaction is performed by an HTTP POST command as shown:

POST [base]/[type]

The request body shall be a FHIR Resource without an id element. The PDS will return a 201 Created HTTP status code, and also return a Location header which contains the new Logical Id and Version Id of the created resource version where [id] and [vid] are the newly created id and version id for the resource version. PDS also returns an ETag header with the versionId and a Last-Modified header.

Location: [base]/[type]/[id]/_history/[vid]

Last-Modified: Sat, 02 Feb 2013 12:02:47 GMT

ETag: W"/1"

The following table shows the other Http status codes when the operation is failed/rejected;

Http Status Code	Meaning
400 Bad Request	Resource could not be parsed or failed basic FHIR validation rules
404 Not Found	Resource type not supported
422 Unprocessable Entity	The proposed resource violated applicable POWER2DM resource profiles.

403 Not Authorized	Authorization is required for the interaction that was attempted, either the OAuth access token is missing or not valid, or user is not authorized for the operation
---------------------------	--

PDS will not support the conditional create operation.

4.4.5 Search Operation

PDS only supports search over Patient compartment. In other words, the clients can only search among records of a specific patient. The search can be done by using both HTTP Post or Get command as shown:

GET [base]/Patient/[pid]/[type]?name=value&...

POST [base]/Patient/[pid]/[type]?_search{?[parameters]}

In FHIR specification, the [pid] refers the identifier of the patient which in our case should be the PSIP described in Section 4.2. We use “-”, in our examples for patient id.

The [type] refers the FHIR resource type, and the result of the query will be the resources that meet the criteria contained in the search parameters of the target patient for that specific resource type. For HTTP GET method, the parameters are a series of name=[value] pairs encoded in the URL. For HTTP POST, it is in the format of application/x-www-form-urlencoded submission.

The PDS determines which of the set of resources meet the specific criteria, and returns the results in the HTTP response as a bundle⁴¹ which includes the resources that are the results of the search.

4.4.5.1 Common Search Parameters

PDS supports the following search parameters for all resources;

Name	Type	Description	Paths
_lastUpdated	date	Date last updated for the resources	Resource.meta.lastUpdated
_profile	uri	Search resources with the tagged POWER2DM Resource profile	Resource.meta.profile

PDS supports the following search control parameters;

Name	Type	Description	Allowed Value
_sort	string	For which search parameter the order should be. The qualifier values can be used to indicate sort order (_sort:asc for ascending and _sort:desc for descending order)	Name of a valid search parameter
_count	number	Number of results per page (See Section 4.4.5.3)	Whole number

If the _sort or _count parameters are not given, the default behaviour will be sorting on _lastUpdated in descending order and returning all results.

The following provides an example search operation that queries patient’s Barriers by requesting only 5 results per page where the order is on the update time of these barriers;

GET [https://www.power2dm.eu/pds/Patient/-/Condition](https://www.power2dm.eu/pds/Patient/-/Condition?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Barrier)
?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Barrier

⁴¹ <https://www.hl7.org/fhir/bundle.html>

&_count=5

&_sort:desc=_lastUpdated

The `_profile` parameter similarly can be used for any defined resource profile to retrieve all that type of specific records of the patient.

4.4.5.2 Search Parameters for Specific Resources

The following sections describe the search parameters for each specific resource profile. As the PDS only supports compartment based search, patient (or subject) is not included in the parameters.

4.4.5.2.1 Diabetes Anamnesis Resource Profile

As there will be only one diabetes anamnesis record for each patient, this record type is only queried by the common parameters, most specifically the `_profile` parameter. No other specific parameter is supported.

e.g. Get the Diabetes Anamnesis of the patient

GET https://www.power2dm.eu/pds/Patient/-/Composition
?_profile='http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_DiabetesAnamnesis'

4.4.5.2.2 Condition Resource Profile

Parameter Name	Type	Description	FHIR Path
code	token	Code for the condition	Condition.code
clinicalStatus	token	The clinical status of the condition	Condition.clinicalStatus

e.g. Does the patient have an active Retinopathy?

GET https://www.power2dm.eu/pds/Patient/-/Condition
?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_DiabetesAnamnesis
&code=E11.3
&clinicalStatus=active

4.4.5.2.3 Problem Resource Profile

Parameter Name	Type	Description	FHIR Path
category	token	Code of the category of the problem	Condition.category
clinicalStatus	token	The clinical status of the problem	Condition.clinicalStatus

e.g. Get Insulin/Medication related active problems of patient

GET https://www.power2dm.eu/pds/Patient/-/Condition
?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Problem
&category=med
&clinicalStatus=active

4.4.5.2.4 Barrier Resource Profile

Parameter Name	Type	Description	FHIR Path
clinicalStatus	token	The status of the barrier	Condition.clinicalStatus
related	reference	The problem that this Barrier is related	Condition.relatedProblem (extension)

e.g. Get active Barriers of patient related with patient's "Low dose insuling problem" (Assuming this Problem record has id 584354)

GET https://www.power2dm.eu/pds/Patient/-/Condition
?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Barrier

&clinicalStatus=active
&related=Condition/584354

4.4.5.2.5 Personal Value Resource Profile

Only common parameters are used for this profile.

4.4.5.2.6 Goal Resource Profile

Parameter Name	Type	Description	FHIR Path
status	token	The status of the Goal	Goal.status
author	reference	Type of the author reference; whether this is a self-management goal or treatment goal. (use “:type” as modifier for the parameter)	Goal.author
addresses	reference	The Personal Value or Problem record that this Goal is addressing	Goal.addresses
targetMeasure	token	The target measure of the Goal (HbA1c, etc)	Goal.goal-target.measure
pertainsToGoal	reference	The Goal record that this goal is addressing	Goal.goal-pertainsToGoal

e.g. Get the active self-management goals of the patient

GET https://www.power2dm.eu/pds/Patient/-/Goal?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Goal&status=in-progress&author:type=Patient

e.g. Get the patient’s goals related with the patient’s Low dose medication problem (assuming record representing the problem has id 21331)

GET https://www.power2dm.eu/pds/Patient/-/Goal?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Goal&status=in-progress&addresses=Condition/21331

e.g. Get the patient’s active HbA1c goal

GET https://www.power2dm.eu/pds/Patient/-/Goal?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Goal&status=in-progress&targetMeasure=http://loinc.org|4548-4

4.4.5.2.7 Action Plan Resource Profile

Parameter Name	Type	Description	FHIR Path
orderer	reference	The author of the action plan; either Self-management action plan if patient is the author or treatment action plan (use “:type” as modifier for the parameter)	ProcedureRequest.orderer
status	token	The status of the action plan	ProcedureRequest.status
scheduled	date	The scheduled time of the Action Plan The prefixes “eq”, “gt”, “lt”, “ge”, “le” can be used for the parameter.	ProcedureRequest.scheduled
related	reference	The related Goal, Barrier or Problem	ProcedureRequest.relatedGoal

			ProcedureRequest.relatedBarrier ProcedureRequest.relatedProblem
--	--	--	--

e.g. Get the active self-management action plans of the patient scheduled after 17-07-2016 and before 23-07-2016;

GET https://www.power2dm.eu/pds/Patient/-/ProcedureRequest?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_ActionPlan&status=in-progress&orderer:type=Patient&scheduled=ge:2016-07-17&scheduled=le:2016-07-23

e.g. Get the action plans related with the Goal of patient regarding increasing physical activity (assuming the Goal record has the id 551548)

GET https://www.power2dm.eu/pds/Patient/-/ProcedureRequest?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_ActionPlan&related=Goal/551548

4.4.5.2.8 MedicationOrder Resource Profile

Parameter Name	Type	Description	FHIR Path
code	token	Return administrations of this medication code	MedicationOrder.medicationCodeableConcept
status	token	Status of the prescription	MedicationOrder.status

e.g. Get the all Medformin medications ordered for patient;

GET https://www.power2dm.eu/pds/Patient/-/MedicationOrder?_profile=http://www.power2dm.eu/pds/StructureDefinition/MedicationOrder&code=http://www.whocc.no/atc|A10BD17

4.4.5.2.9 Appointment Resource Profile

Parameter Name	Type	Description	FHIR Path
date	date	Appointment date time. The prefixes "eq", "gt", "lt", "ge", "le" can be used for the parameter.	Appointment.start
status	token	The status of the appointment	Appointment.status

e.g. Get planned Appointments next month (before August 31)

GET https://www.power2dm.eu/pds/Patient/-/Appointment?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Appointment&status=booked&date=le:2016-08-31

4.4.5.2.10 Encounter Resource Profile

Parameter Name	Type	Description	FHIR Path
date	date	Encounter date time. The prefixes "eq", "gt", "lt", "ge", "le" can be used for the parameter.	Encounter.period.start
status	token	The status of the appointment	Encounter.status
appointment	reference	The appointment that plans this encounter	Encounter.appointment

e.g. Get the encounter planned by the appointment (with id 476868)

GET https://www.power2dm.eu/pds/Patient/-/Encounter?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_Encounter&appointment=Appointment/476868

4.4.5.2.11 Observation Resource Profiles

The following query parameters cover all of the Observation resource profiles defined.

Parameter Name	Type	Description	FHIR Path
code	token	The code of the observation	Observation.code
date	date	The date of the observation	Observation.effective[x]
device	reference	The device that makes the observation	Observation.device
actionPlan	reference	The action plan that is acknowledged by this observation	Observation.acknowledgedActionPlan (extension)
component-code	token	The code of the component	Observation.component.code
value-quantity	quantity	The value of the single component observation	Observation.valueQuantity
value-concept	token	The value of the single component observation	Observation.valueCodeableConcept
component-value-concept	token	The value of the component	Observation.component.valueCodeableConcept
component-value-quantity	quantity	The value of the component	Observation.valueQuantity

e.g. Get the blood glucose measurements of patient this month (after 01.07.2016) (Single observation)

GET <https://www.power2dm.eu/pds/Patient/-/Observation?code=http://loinc.org|41653-7&date=ge:2016-07-01>

e.g. Get all the CGM measurements of the patient

GET <https://www.power2dm.eu/pds/Patient/-/Observation?code=http://power2dm.eu|cgm>

e.g. Get the lab results records including HDL measurement

GET <https://www.power2dm.eu/pds/Patient/-/Observation?code=http://snomed.info/sct|275924004&component-code=http://loinc.org|14646-4>

e.g. Get the dietary intake records for today (19.07.2016)

GET <https://www.power2dm.eu/pds/Patient/-/Observation?code=http://snomed.info/sct|364395008>

e.g. Get the Depression Questionnaire result records for patient

GET <https://www.power2dm.eu/pds/Patient/-/Observation?code=http://power2dm.eu|q-phq9>

e.g. Get the Blood Glucose measurements of patient last month which are higher than 140 mg/dl

GET <https://www.power2dm.eu/pds/Patient/-/Observation>

?code= <http://loinc.org|41653-7>
 &date=ge:2016-07-01
 &value-quantity=gt:140| <http://unitsofmeasure.org|mg/dl>

e.g. Get the lab results records including HDL measurement lower than 40 mg/dl

GET <https://www.power2dm.eu/pds/Patient/-/Observation>
 ?code= <http://snomed.info/sct|275924004>
 &component-value-quantity=lt:40| <http://unitsofmeasure.org|mg/dl>

e.g. Get the results (the score) of the “Diabetes Self-Management (DSMQ-R)” questionnaire applied to the patient.

GET <https://www.power2dm.eu/pds/Patient/-/Observation>
 ?_profile= <http://www.power2dm.eu/pds/StructureDefinition/QuestionnaireResultScore>
 &code=<http://power2dm.eu|q-dsmqr>

4.4.5.2.12 Risk Assessment Resource Profile

Parameter Name	Type	Description	FHIR Path
method	token	The method of the risk assessment	RiskAssessment.method
date	date	The date of the risk assessment	RiskAssessment.date
performer	reference	The performer of the assessment	RiskAssessment.performer
prediction-outcome	token	The code for assessment outcome	RiskAssessment.prediction.outcome

e.g. Get the UKPDS risk scores calculated for patient

GET <https://www.power2dm.eu/pds/Patient/-/RiskAssessment>
 ?_profile= http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_RiskAssesment
 &code= <http://power2dm.eu|ukpds-cv-entity>

4.4.5.2.13 Prediction Result Resource Profile

Parameter Name	Type	Description	FHIR Path
method	token	The method of the prediction	RiskAssessment.method
date	date	The date of the prediction	RiskAssessment.date
performer	reference	The performer of the prediction	RiskAssessment.performer
prediction-outcome	token	The code for prediction outcome	RiskAssessment.prediction.outcome

e.g. Get the Marvel Predictions done for patient this year

GET <https://www.power2dm.eu/pds/Patient/-/RiskAssessment>
 ?_profile= http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_PredictionResult
 &code= <http://power2dm.eu|marvel-pred>
 &date=eq:2016

e.g. Get the Marvel prediction records of patient that have BMI predictions

GET <https://www.power2dm.eu/pds/Patient/-/RiskAssessment>
 ?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_PredictionResult
 &code= <http://power2dm.eu|marvel-pred>
 &prediction-outcome= <http://loinc.org|39156-5>

4.4.5.2.14 QuestionnaireResult Resource Profile

Parameter Name	Type	Description	FHIR Path
questionnaire	reference	The questionnaire that is responded	QuestionnaireResult.questionnaire

authored	date	The date that questionnaire is authored	QuestionnaireResult.authored
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e.g. Get the results (the answers given by patient) of the “Diabetes Self-Management (DSMQ-R)” questionnaires applied to the patient.

GET https://www.power2dm.eu/pds/Patient/-/QuestionnaireResult?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_QuestionnaireResult&questionnaire=Questionnaire/q-dsmqr

4.4.5.2.15 Medication Administration Resource Profile

Parameter Name	Type	Description	FHIR Path
code	token	The medication administered	Medication.code
effectivetime	date	The time of administration	Medication.effectiveTimeDateTime
prescription	reference	The Medication Order that this administration is about	Medication.prescription

e.g. Get Medication administration records of patient for short-acting insulins this month (after 1.7.2016)

GET [https://www.power2dm.eu/pds/Patient/-/MedicationAdministration?code= ...&effectivetime=ge:2016-07-01](https://www.power2dm.eu/pds/Patient/-/MedicationAdministration?code=...&effectivetime=ge:2016-07-01)

e.g. Get Medication administration records of patient related with the medication order (assuming record id 48872)

GET <https://www.power2dm.eu/pds/Patient/-/MedicationAdministration?prescription=MedicationOrder/48872>

4.4.5.2.16 Applied Intervention Resource Profile

Parameter Name	Type	Description	FHIR Path
code	token	Returns the specific interventions identified by given code	Procedure.code
date	date	The time of intervention	Procedure.performed[x]
reason	reference	The related barriers, problems	Procedure.reasonReference
relatedGoal	reference	The related goal	Procedure.relatedGoal (extension)

e.g. Get the interventions applied to patient last week

GET https://www.power2dm.eu/pds/Patient/-/Procedure?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_AppliedIntervention&date=ge:2016-07-01

e.g. Get the interventions applied to patient related with his “too much carb” barrier (assuming the record id for this barrier is 212256)

GET https://www.power2dm.eu/pds/Patient/-/Procedure?_profile=http://www.power2dm.eu/pds/StructureDefinition/POWER2DM_AppliedIntervention&reason=Condition/212256

4.4.5.3 Bundling results and paging

PDS conforms to the paging methodology defined in the FHIR specification⁴². If the client uses the `_count` parameter in the search, the paging will be applied and the resulting Bundle entity will be as follows;

FHIR Path	Card.	FHIR Data Type	Description
Bundle.type	1..1	code	The fixed "searchset" value will be used to indicate that the bundle contains the search results
Bundle.total	1..1	unsignedInt	The total number of matched resources
Bundle.entry.resource	0..*	Resource	The resource content returned as a result
If paging is applied			
Bundle.link[0]	0..1		The link to self page (self link)
Bundle.link[1]	0..1		The link to first page
Bundle.link[2]	0..1		The link to previous page
Bundle.link[3]	0..1		The link to next page
Bundle.link[4]	0..1		The link to last page

4.4.6 Batch/transaction Operation

"The batch and transaction interactions submit a set of actions to perform on a server in a single HTTP request/response. The actions may be performed independently as a "batch", or as a single atomic "transaction" where the entire set of changes succeed or fail as a single entity." The operation will be handled as described in the FHIR specification, where individual operations should conform to the operations definitions described above.

A batch or transaction interaction is performed by an HTTP POST command as shown:

POST [base]

The content of the post submission is a Bundle⁴³ with Bundle.type = batch or transaction. Each entry carries request details (Bundle.entry.request) that provides the HTTP details of the action in order to inform the system processing the batch or transaction what to do for the entry. PDS will conform to processing rules and responses defined in base FHIR specification.

4.4.7 Subscription to Specific Resource Types

FHIR has defined a specific record type, Subscription⁴⁴, to enable clients to subscribe to specific records. Like other resources, clients can use create operation to create a Subscription record including the details of subscription. Once a subscription is registered, the FHIR server checks every resource that is created or updated, and if the resource matches the given criteria, it sends a message on the defined "channel" so that another system can take an appropriate action.

PDS supports this mechanism with only by "rest-hook" channel. In this channel, client registers a REST service URL within the subscription and PDS will send a HTTP Post message with empty payload to the registered service URI if the criteria are met. The following table shows the details of POWER2DM resource profile.

FHIR Path	Card.	FHIR Data Type	Description
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⁴² <https://www.hl7.org/fhir/http.html#paging>

⁴³ <https://www.hl7.org/fhir/bundle.html>

⁴⁴ <https://www.hl7.org/fhir/subscription.html>

Subscription.criteria	1..1	string	This is the criteria over the records for the subscription. PDS will only support patient compartment based simple resource type criteria. In other words, clients can only register to the specific record type of a specific patient with no further query parameters apart from <code>_profile</code> . e.g. <code>/patient/651542/ProcedureRequest?_profile=POWER2DM_ActionPlan</code>
Subscription.reason	1..1	string	Description of why this subscription was created
Subscription.status	1..1	code	Status of the subscription (active error off)
Subscription.error	0..1	string	Latest error note if there is an error for accessing the Rest service registered by the client
Subscription.channel	1..1		Channel details
Subscription.channel.type	1..1	code	Use "rest-hook"
Subscription.channel.endpoint	1..1	uri	The uri of the Restful service to be registered for notification
Subscription.channel.header	1..1	string	The header to include to the notification (the Http POST message) for authorization. e.g. "Authorization: Bearer secret-token-abc-123"

4.4.8 Value Sets

Table 35 lists all the value sets used in POWER2DM. These value sets are accessible from the PDS API, as ValueSet is another resource type in FHIR. The web URL for these value sets will be as follows;

<https://power2dm.eu/pds/ValueSet/<ValueSetName>>

e.g. <https://power2dm.eu/pds/ValueSet/pdm-problems>

Table 35 POWER2DM Value Sets

Name	Definition	Code Lists
pdm-patient-ethnicity	The ethnicity of patient	POWER2DM
pdm-practitioner-roles	The structural roles of Practitioners in POWER2DM care program	POWER2DM
pdm-device-types	The device types used in POWER2DM care program	SNOMEDCT
pdm-conditions	The diagnosis/conditions covered in POWER2DM care program	ICD-10
pdm-condition-categories	The categories of conditions in POWER2DM care program	POWER2DM
pdm-cond-verification-status	The verification status list for Conditions, Problems, and Barriers	Restriction on cond-ver-status ⁴⁵
pdm-problems	The list of diabetes related problems covered in POWER2DM care program	SNOMEDCT, POWER2DM
pdm-barriers	The list of diabetes related barriers covered in POWER2DM care program	SNOMEDCT, POWER2DM
pdm-complaints	The list of complaints covered in POWER2DM care program	SNOMED-CT
pdm-personal-values	The list of personal values covered in POWER2DM care program	POWER2DM
pdm-goal-categories	The list of main categories for POWER2DM goals	POWER2DM
pdm-goal-status	The status codes for POWER2DM Goals	Restriction on goal-status ⁴⁶

⁴⁵ <http://hl7.org/fhir/ValueSet/condition-ver-status>

⁴⁶ <https://www.hl7.org/fhir/valueset-goal-status.html>

pdm-goal-target	The list of target measurements that POWER2DM Goals may have	SNOMEDCT, LOINC, POWER2DM
pdm-goal-tags	The list of tags for further application level categorization for POWER2DM Goals	POWER2DM
pdm-actions	The list of actions that can be planned(suggested) for patient in POWER2DM Care program	POWER2DM
pdm-action-categories	The list of main categories for POWER2DM Action Plans	POWER2DM
pdm-action-tags	The list of tags for further application level categorization for POWER2DM Action Plans	POWER2DM
pdm-medications	The list of medications that are covered in POWER2DM Care program	POWER2DM
pdm-encounter-types	The encounter types in POWER2DM care program	POWER2DM
pdm-observations	The list of codes to represent the observations in POWER2DM care program	SNOMEDCT, LOINC, POWER2DM
pdm-smoking-status	The smoking status list used in POWER2DM care program	SNOMEDCT
pdm-physical-activities	The list of physical activities covered in POWER2DM	POWER2DM
pdm-mind-states	This list of mind states covered in POWER2DM (based on Spire)	POWER2DM
pdm-risk-assessment-methods	The list of risk assessment methods (models) used in POWER2DM	POWER2DM
pdm-risk-assessment-outcomes	The list of risk assessment outcomes produced in POWER2DM	POWER2DM
pdm-prediction-methods	The list of prediction methods used in POWER2DM	POWER2DM
pdm-prediction-motivations	The list of codes to identify the purpose of prediction operation	POWER2DM
pdm-prediction-outcomes	The list of outcomes predictable in POWER2DM	POWER2DM
pdm-note-types	The list of type of notes used in POWER2DM	POWER2DM
pdm-settings-groups	The list of user settings groups used in POWER2DM	POWER2DM
pdm-communication-categories	The list of patient communication(intervention) categories in POWER2DM	POWER2DM
pdm-communication-preferences	The list of possible preferences for each communication in POWER2DM	POWER2DM