Unified Study Definitions Model Implementation Guide (USDM-IG)

Version 3.0 (Draft)

Prepared by the DDF Team

Notes to Readers

- This is the draft version 3.0 of the Unified Study Definitions Model Implementation Guide (USDM-IG v3.0). It is intended for public review only and is not a final version.

Revision History

Date	Version
2024-01-26	3.0 Draft
2023-06-27	2.0 Final

See Appendix E for Representations and Warranties, Limitations of Liability, and Disclaimers.

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1 Introduction

CDISC, in collaboration with TransCelerate Biopharma and Accenture as a part of TransCelerate's Digital Data Flow (DDF) Project, have developed a Study Definition Reference Architecture called the Unified Study Definitions Model (USDM).

The aim of TransCelerate's DDF initiative is to optimize study start-up (SSU) processes and automate system configuration and readiness. The current state typically involves disconnected study design services and assets and transcription or re-entry of the same information into many systems across sponsors, contract research organizations, and systems vendors. This inefficiency results in systems configuration falling onto the critical path for SSU and adds risks for transcription errors and unnecessary delays.

Ideally, a solution would enable interoperability across multiple systems in a clinical study, improve efficiency and data quality, and reduce cycle times. That solution should capture protocol elements and present them in standardized formats to enable automated configuration of downstream systems and efficient consumption of protocol information across the study ecosystem.

The challenge is that SSU system configuration workflow and asset creation is currently not automated, which makes it inefficient and increases the risk of error. Current workflows also include a number of redundant, manual activities. Sponsors are not able to utilize resources efficiently due to the siloed, document-based environment. Additional information can be found on the TransCelerate Digital Data Flow Solutions web page.

The collaborative effort between TransCelerate and CDISC has enabled the development of the USDM reference architecture in conjunction with development of a Study Definitions Repository (a reference implementation of the USDM architecture). For more information on the SDR, visit the TransCelerate DDF GitHub site and the SDR Github Site.

1.1 Purpose

The USDM Implementation Guide (USDM-IG) is intended for companies and individuals involved in the set-up of clinical studies—sponsors or stakeholders involved in upstream (protocol and content authoring tools)—and downstream consumers of system (e.g., electronic data capture (EDC), clinical trial management, trial master file) and document (e.g., protocol, clinical study reports, statistical analysis plans) standardized digitized study definitions.

This document provides users with sufficient information to understand the USDM and also its potential implementations with the study design process by showing examples of the types of study definition information that can be represented in the USDM.

1.2 Organization of this Document

This document is divided into the following sections:

- Section 1, Introduction, provides an overall introduction to the purpose and goals of the USDM-IG.
- Section 2, Fundamentals of the USDM, provides a boundary of the scope of this version of the USDM and what use cases this version is intended to support.
- Section 3, Relationship to Other Standards and Formats, describes at a high level how the USDM relates to other standards (both CDISC and non-CDISC) and to the TransCelerate Common Protocol Template.
- Section 4, USDM Features, provides an overview of enhancements that support increased trial complexity.
- Section 5, USDM Data Dictionary, illustrates the types of information that can be represented using the USDM, and includes various study designs ranging in complexity.
- Section 6, USDM API, provides information on the USDM application programming interface.
- Section 7, Mapping to Other Standards and Formats, describes the alignment between the USDM and SDTM Trial Design domains and controlled terminology elements, and provides definitions for protocol registration data elements submitted to ClinicalTrials.gov.

- Appendices provide additional background material and describe other supplemental material relevant to the USDM.

Examples of use of the model in JSON, .PNG, and .XLS format as well as other information can be found here.

1.3 How to Read this Document

1. First, become familiar with the DDF project; see the TransCelerate DDF Project web page and CDISC DDF resources. If new to DDF, visit the TranCelerate YouTube channel, which includes several videos describing DDF.
2. Read this guide all the way through (without skipping any sections) at least once.
3. Finally, revisit any sections of particular interest.

2 Fundamentals of the USDM

The USDM comprises 4 parts, which are official CDISC standards:

1. Unified Study Definitions Model (USDM) class diagram represented as a unified modeling language (UML) class diagram
2. Application programming interface (API) specification
3. CDISC Controlled Terminology
4. Unified Study Definitions Model Implementation Guide (USDM-IG)

USDM v1.0

USDM v1.0 (released August 2022) provided a base model of structured study design.

Please note that USDM v1.0 did not have a corresponding implementation guide. The USDM-IG was initially developed for USDM v2.0 and further updated for USDM v3.0.

USDM v2.0

Building on the USDM v1.0 foundation, USDM v2.0 (released June 2023) was developed to satisfy an agreed set of use cases based around

- updates to the USDM that enable greater population of SSU elements and represent structured study design information for more complex trials,
- updates to the USDM that support EDC automation, and
- updates to the USDM that demonstrate population of the TransCelerate Common Protocol Template (CPT).

Support for More Complex Trials

The first version of the USDM provided a model for simple study designs. Version 2.0 implemented additional elements that allow for representation of more complex study designs in USDM. Section 4, USDM Features, provides an overview of enhancements that support increased trial complexity. One main area of development has been the implementation of study timing (see Section 4.14) within the model, allowing for complex timing and visit structures to be represented.

Enabling EDC Automation

In order to support EDC automation, the CDISC Biomedical Concepts model was adapted and included as a submodel in the USDM. The addition of biomedical concepts to the model adds a machine-readable "data" layer to the study design. This data layer can be used in a variety of ways to inform about what data relates to particular assessments within a study design. This biomedical concepts model not only assists in informing an EDC system as to the individual data items required for an assessment (e.g., automating identification of a form in an EDC library with the same/similar set of biomedical concepts) but also provide basic information required to build a new form should there be no EDC library, or no form that matches.

Implementation of the biomedical concepts model in the USDM provides a machine-readable data specification that can support other data-source use cases such as digital health technologies, electronic patient-reported outcomes (ePROs), and electronically supplied data (e.g., central lab, central ECG data).

Populating protocol standards

In Version 2.0, additional elements were added to the model as a proof-of-viability (POV) exercise, demonstrating that structured study design information could be moved from an upstream study design application into USDM format and then used to populate the TransCelerate CPT. Additional information on the USDM elements used for this POV can be found in Section 7.3, Use of USDM for Populating Protocol Content. Note that only a selected set of CPT elements is included for the POV.

USDM v3.0

USDM v3.0 development topics included:

- Ability to represent the draft ICH Clinical electronic Structured Harmonised Protocol (CeSHarP) developed by the ICH M11 group in USDM
- Add elements to expand the population of SDTM trial design population
- Identify elements within USDM that can assist in population of trial planning elements for clinical trial registration in trial registries
- Addition of elements and model amendments required to represent structured study design information for more complex studies, including complex cohort trial designs
- Model enhancements to support use of the USDM and ensure consistency within the model

Representation of ICH M11 CeSHarP in USDM

Working closely with ICH, USDM v3.0 has been aligned to cover the breadth of sections found in the ICH M11 CeSHarP template. This will allow a USDM study design to be represented in the ICH CeSHarP template. **Note:** At the time of publication of USDM v3.0, ICH CeSHarP was still in the development phase. In future phases of USDM development, CDISC will continue to collaborate with the ICH team in order to ensure that USDM remains aligned with the ICH M11 CeSHarP template.

SDTM Trial Design Population

During development of USDM v2.0, elements within the USDM were identified that would allow data from a USDM compliant system to be used to populate SDTM Trial Design datasets related to trial planning. This was expanded during USDM v3.0 development to include additional elements that can be used for SDTM Trial Design population. Additional information can be found in Section 7.1, Creation of SDTM Trial Design Domains.

Clinical Trial Registry Population

Working alongside clinical trial registry subject-matter experts (SMEs), an evaluation was performed to determine how USDM can be utilized to assist in the population of elements required for clinical trial registries. In Version 3.0, this was restricted to ClinicalTrials.gov. Additional information can be found in Section 7.2, Informing ClinicalTrials.gov Registry

Support for More Complex Trials

An evaluation was performed to determine model changes that could support more complex cohort trials designs. This resulted in new USDM classes being developed (i.e., Population Definitions, Study Cohort, Characteristic) to support these types of studies. Additional information can be found in Section 4.19, Populations, Cohorts and Eligibility Criteria.

Model Enhancements

Version 3.0 includes model enhancements to support use of the USDM and ensure consistency within the model, such as updating the UML to make it a more logical model, removing the API implementation elements and links, and making naming more consistent between classes. Additional information can be found in Section 4.2, Principles, Section 4.3, Naming Conventions, Section 4.4, Internal Identifiers Within the Model, and Section 4.5, Controlled Terminology.

3 Relationship to Other Standards and Formats

The USDM covers a wide range of concepts related to study design that also appear in other published standards such as trial registry standards (EudraCT, ClinicalTrials.gov), HL7 FHIR standards, and ICH guidance documents. As part of the development process, these standards were used as input in order to try to ensure harmonization with these standards, where possible.

3.1 Relationship to Other CDISC Standards

The USDM development process relies on published CDISC standards and other products that serve as references for modeling and naming conventions. To the extent possible, an effort has been made to align or be compatible with these sources where the content was determined to be conceptually identical or closely related to those being developed for the USDM.

BRIDG

The Biomedical Research Integrated Domain Group (BRIDG) is a CDISC, HL7, and ISO "standard for biomedical research concepts designed to support computable semantic interoperability."[1] BRIDG can be used for various purposes: as a reference model, a data integration/mapping solution, an exchange format, an ontology, or to create a BRIDG-based database. The use of BRIDG helps support the meaningful exchange of data between software systems and databases.

When BRIDG is used as a reference model to create or add new content to a standard, it can help ensure that relationships between and among biomedical research concepts represented using the standard are consistently modeled.

PRM

The Protocol Representation Model (PRM) provides a standard for planning and designing a research protocol with focus on study characteristics such as study design; eligibility criteria; and requirements from ClinicalTrials.gov, World Health Organization (WHO) registries, and EudraCT registries. The PRM assists in automating CRF creation and EHR configuration to support clinical research and data sharing.

Note: The PRM was released in 2012 and includes some overlap with the USDM. It is anticipated that the USDM will develop to be more content rich and implementable as a model and will therefore supersede the PRM.

SDTM and SDTMIG

The Study Data Tabulation Model (SDTM) provides a standard for organizing and formatting data to streamline processes in collection, management, analysis, and reporting. Implementing SDTM supports data aggregation and warehousing, fosters mining and reuse, facilitates sharing, helps perform due diligence and other important data review activities, and improves the regulatory review and approval process. The SDTM provides a standard model for organizing and formatting data for human and animal studies; the SDTM Implementation Guide (SDTMIG) is intended to guide the organization, structure, and format of standard clinical trial tabulation datasets. The SDTMIG was developed to support data submitted to a regulatory authority, such as the US Food and Drug Administration (FDA), but is not restricted to use in regulated submissions. The SDTM is one of the required standards that sponsors must use, as specified in the FDA's Data Standards Catalog,[2] for New Drug Applications (NDAs), Abbreviated New Drug Applications (ANDAs), and certain Biologics License Applications (BLANDAs).

The SDTMIG includes a section related to Trial Design Model datasets. Section 9.1 (Annex IIIa and Annex IIIb) of the ICH *Guideline for Industry: Structure and Content of Clinical Study Reports*[3] calls for a brief, clear description of the overall plan and design of the study, and supplies examples of charts and diagrams for this purpose. Each annex corresponds to an example trial and provides a diagram describing the study design and a table showing the schedule of assessments. The Trial Design Model provides a standardized way to describe aspects of the planned conduct of a clinical trial shown in the study design diagrams of these examples. Standard Trial Design datasets allow reviewers to

- clearly and quickly grasp the design of a clinical trial,

- compare the designs of different trials,
- search a data warehouse for clinical trials with certain features, and
- compare planned and actual treatments and visits for subjects in a clinical trial.

Modeling a clinical trial in this standardized way requires the explicit statement of certain decision rules that may not be addressed or may be vague or ambiguous in the usual prose protocol document. Prospective modeling of the design of a clinical trial should lead to a clearer, better protocol. Retrospective modeling of the design of a clinical trial should ensure a clear description of how the trial protocol was interpreted by the sponsor.

Automated creation of SDTM Trial Design datasets is possible using data structured in USDM v3.0 format as detailed in Section 7.1, Creation of SDTM Trial Design Domains.

Controlled Terminology

CDISC, in collaboration with the National Cancer Institute's (NCI) Enterprise Vocabulary Services (EVS), supports the controlled terminology (CT) needs of the CDISC standards. *Controlled terminology* is the set of codelists, definitions, and valid values used with CDISC model elements. Within CDISC there are many volunteer teams that evaluate and manage CDISC CT. For example, the Protocol Entities Terminology Team develops and publishes the semantics for concepts found in clinical research protocols; the CDISC Glossary Team harmonizes the semantics and definitions for concepts commonly found in CDISC standards documents. The DDF terminology subset of CDISC CT is one of the main deliverables supporting the USDM, and development of CDISC CT for the USDM has been harmonized with existing, published CDISC CT (including SDTM, Protocol, and CDISC Glossary) in order to ensure maximum reuse of terms and definitions. Any new CT that has been developed for the USDM has undergone review from the Protocol Entities and CDISC Glossary Teams. USDM-related CT is developed and published using the same process as all other CDISC CT, in order to ensure a consensus based, fit for use, and harmonized set of terms.

CTR

Clinical Trial Registry (CTR)-XML lets technology vendors implement tools that support a “write once, use many times” solution based on a single XML file that holds the information needed to generate submissions for multiple clinical trials for clinical trial registry submissions, primarily to the World Health Organization (WHO), the European Medicines Agency (EMA), the EudraCT Registry, and United States ClinicalTrials.gov.

Working alongside clinical trial registry SMEs, an evaluation was performed to determine how USDM could be utilized to assist in the population of elements required for clinical trial registries. In Version 3.0, this was restricted to ClinicalTrials.gov. Additional information can be found in Section 7.2, Informing ClinicalTrials.gov Registry.

ODM

Operational Data Model (ODM)-XML is a vendor-neutral, platform-independent format for exchanging and archiving clinical and translational research data, along with their associated metadata, administrative data, reference data, and audit information. The ODM-XML facilitates the regulatory-compliant acquisition, archival, and exchange of metadata and data. It has become the language of choice for representing CRF content in many EDC tools.

ODM-XML v2.0 (released August 2023) added significant functionality to the ODM standard, including:

- Multilingual support
- Data query support
- Traceability (Trace-XML features) support
- HL7 FHIR interoperability
- Study/Trial Design Model in XML (SDM-XML) integration and enhancement
- CDISC 360 support
- Data capture

Although the USDM is a reference model and the ODM is a transport model, there is overlap between the standards in terms of elements related to study design (e.g., biomedical concepts) and elements related to EDC build (e.g., visits, forms, variables). Therefore, during the development of the USDM, areas of development for ODM-XML v2.0 were investigated and, where possible, aligned with USDM.

SDM

Study/Trial Design Model in XML (SDM-XML) is an extension of the ODM-XML and allows organizations to provide rigorous, machine-readable, interchangeable descriptions of the designs of their clinical studies, including treatment plans, eligibility, and times and events. SDM-XML defines 3 key submodules (i.e., structure, workflow, timing), permitting various levels of detail in any representation of a clinical study's design.

Note: SDM v1.0, released in 2011, was incorporated into ODM-XML v2.0. The SDM was used as an input reference model during the development of the USDM.

3.2 Relationship to Other Standards

ICH M11 Guideline, Clinical Study Protocol Template, and Technical Specifications

The ICH M11 guideline[4] introduced CeSHarP; the technical specification ensures that protocols are prepared in a consistent fashion and provided in a harmonized data-exchange format acceptable to regulatory authorities. The guideline, clinical study protocol template, and technical specifications were released in October 2022 for public review; where possible, these were used as reference input during USDM v3.0 development. Working closely with ICH, USDM v3.0 has been aligned to cover the breadth of sections found in the ICH M11 CeSHarP template. This allows a USDM study design to be represented in the ICH CeSHarP template. Note: At the time of publication of USDM v3.0, the ICH CeSHarP was still in the development phase. In future phases of USDM development, CDISC will continue to collaborate with the ICH team in order to ensure that USDM remains aligned with the ICH M11 CeSHarP template.

HL7 FHIR SOA

The Vulcan Schedule of Activities (SOA) Project defines a pattern for a clinical trial SOA structure using FHIR resources and processes that enables sharing, interpretation, and implementation in healthcare (EHR, PHR) systems. When a subject is enrolled in a study, research personnel will be able to attach them to the ResearchSubject and ResearchStudy, connecting the CarePlan with the schedule of activities (the research visits and corresponding tests/activities).

4 USDM Features

4.1 Overview

The USDM normative form is a UML model. The USDM provides the ability to define a version of a clinical study that includes:

1. The main study details, such as:
    a. Version of the external protocol that the study relates to
    b. Various identifiers allocated to the study
2. One or more study designs within the study, with each study design detailing:
    a. Arms and epochs within the design and the relationships between them
    b. Encounters planned for the study and the relationship with the epochs of the study
    c. A detailed data specification for the data to be captured as part of the study
    d. Procedures to be performed as part of the study design
    e. Timing of collection of data and the performance of procedures
    f. Subject populations defined within the study design
    g. Objectives and endpoints defined within the study design
    h. Study estimands defined within the study design
    i. Interventions defined as part of the study design
    j. The relevant indication

Although the USDM is designed to hold a single version of a study, the model can be used to implement systems that hold multiple versions of multiple studies.

Note: The use of the terms above and their respective definitions are defined within the USDM class definitions and the related controlled terms.

4.2 Principles

The main principles applied to the development of the USDM include:

- Try not to reinvent the wheel. At the same time, improve. Use and learn from existing models.
- Align with existing CDISC models as much as possible but do not be constrained by them.
- Where sensible, provide standardized codes from CDISC CT. Allow for aliases.
- Allow for references to any CT where sensible.
- Do not recreate the paper world.
- Be aware of model versus presentation.
- The model should represent a complete protocol, not a partially completed one. Implementators should be able to relax constraints if they are building protocols.
- The model should not prevent implementators from extending the model.
- Keep the approach simple at the start; iterate, learn, and add complexity as it is understood.
- Support the planned design, not subsequent execution.
- Support the whole protocol document (phase 3 onwards; not true for phases 1 and 2).

With respect to terminology, principles include:

- Standardize on a codelist/value set; be prescriptive.
- Where there is misalignment, standardize on the best global standard.
- Allow for regional differences (e.g., FDA in the US).

4.3 Naming Conventions

General

USDM v3.0 defines standard naming conventions. This includes improving the names of classes and, in particular, attributes to make the model more implementation friendly.

This section details the conventions used for naming and the use of attribute datatypes.

Class and Attribute Naming

The naming convention as currently used is:

- Nouns are used for class names.
- Every class has an attribute named "id" such that a unique identifier, within the scope of a study, can be allocated to instances of the class.
- A class can have a number of standard attributes. The attribute names should not be used for any other purpose:
  - name: the literal identifier (i.e., distinctive designation) for an instance of the class
  - description: a narrative representation for an instance of the class.
  - label: the short descriptive designation for an instance of the class**Note:** a class may employ these attributes if they are required and thus not all classes use them.
- A class can have additional attributes. These are currently prefixed with the class name or a shorted version thereof. The naming of these attributes will be reviewed going forward to improve the names if required.

Data Types

Attributes have been provided with simple data types. The USDM generally avoids the use of complex data types. Where there is a need for a complex data type, a separate class is created.

Relationships

Relationships have, in general, been formed from the names of the class at either end of the relationship with singular names used for one-to-one relationships and plural names used for one-to-many relationships.

4.4 Internal Identifiers Within the Model

Each class defined within the UML has an identification attribute that can be used to provide a unique identifier for an instance of the class. The identifier should be unique and self-consistent within the scope of a version of a study. No attempt is made to define the form, type, or structure of these identifiers; the attributes are defined as strings. The only exception is the identifier at the head of the model within the Study class. Implementations are free to allocate the value to this field using, for example, a UUID, to ensure uniqueness within the implementation.

4.5 Controlled Terminology

Controlled terminology is referenced in multiple places across the USDM. So as to provide a mechanism to refer to controlled terms in a consistent manner, the USDM employs the Code class. The Code class uses 4 attributes to define the term being used (a code and decode pair), the terminology from which the term is taken, and the version of that terminology. This allows for any controlled term—whether CDISC, SNOMED, LOINC, or other—to be referred to in a consistent manner.

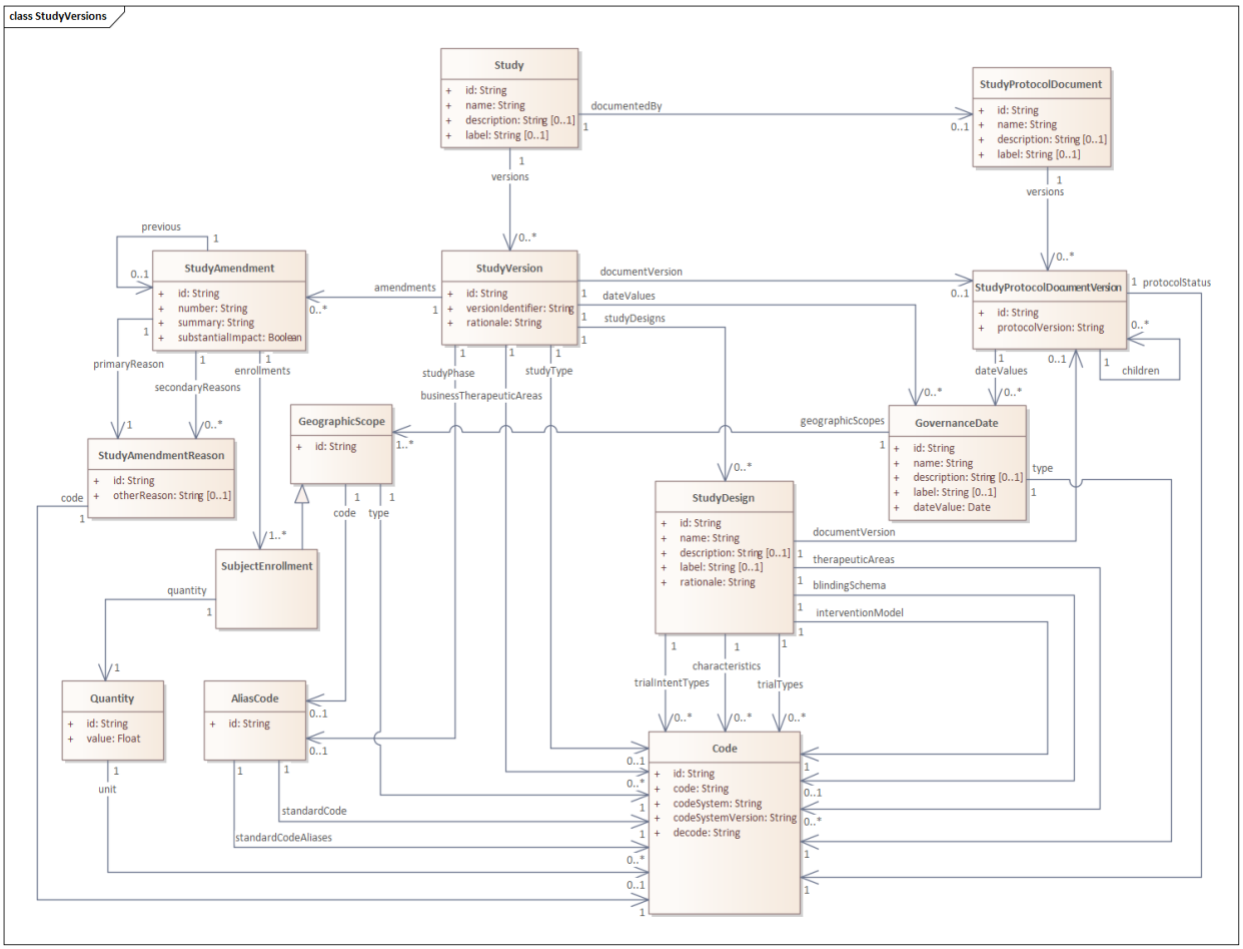
Certain attributes within the USDM Code class have been constrained to using terms from a given codelist from specified terminologies; these are specified in the controlled terminology spreadsheet. Although most of the terms referenced are CDISC CT, some other controlled vocabularies are referenced.

Where a CDISC code is demanded by the model but flexibility is needed, users may include other terms (aliases) using the AliasCode class. Here 1 standard term is required but zero, 1, or more aliases can be provided. One particular instance is geographic references. The standard code should be from ISO 3166; other code aliases (e.g., GENC) can be provided.

4.6 Study, Protocols, and Amendments

The Study class is the root of the USDM, collecting together the definition of the study and its corresponding versions as a whole. A study is documented by a study protocol document. The overarching study and the study protocol document each have their versioning with corresponding governance dates. These dates are to be focused to a specific geographic scope (e.g. global, regional, country).

Because the traditional paper/PDF protocol document has been split into 2 parts (i.e., the document and an electronic design using the USDM), there is a need to link which electronic definition is valid with which version of the document. The Study Version class links to the StudyProtocolVersion class to define to which versions of an external protocol document the study definition relates. The study version provides a few basic study details (e.g., type, phase, rationale) and links the study with its constituent parts that include 1 or more study designs (see Section 4.8), identifiers, and titles (last 2 not shown in the following diagram) for the study.



A study version may represent an amendment. Corresponding amendment details—including reasons for the amendment, number or percentage of subjects enrolled at time of amendment, and substantial impact—are captured in the Amendment class. This can be reflected in the corresponding study protocol document version via the

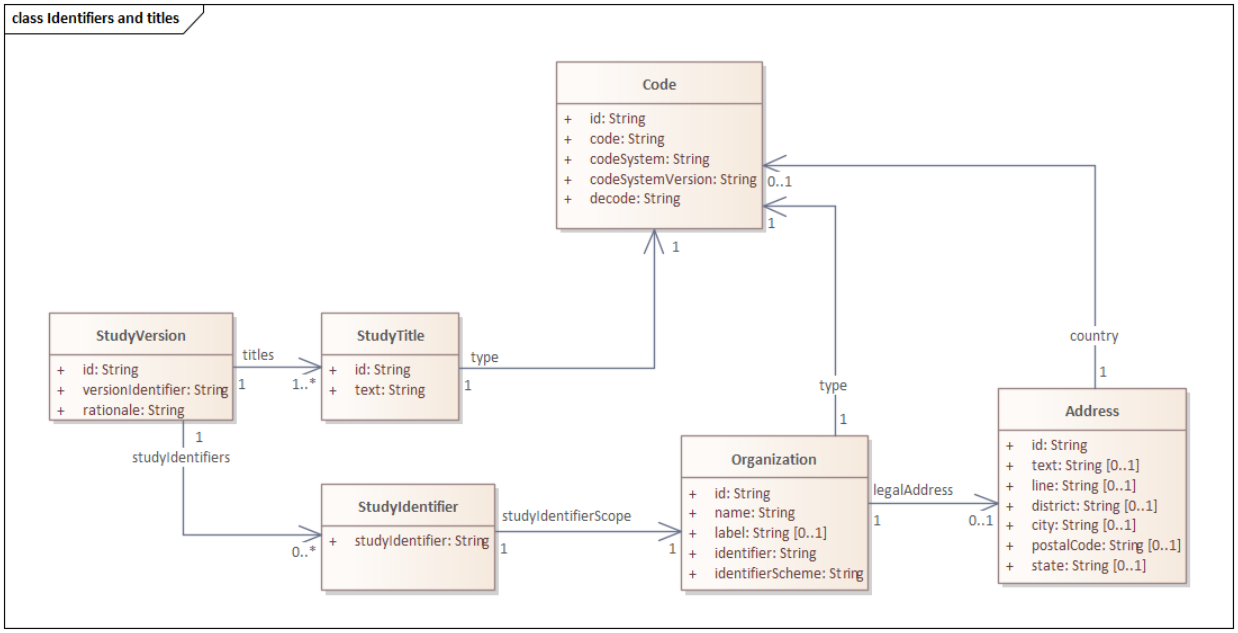
StudyVersion class. The protocol document version content is captured in the USDM as unstructured content (see Section 4.19) in the NarrativeContent class.

The StudyVersion class also allows for stating the business therapeutic area. **Note:** The business therapeutic area is provided for downstream processes and for sponsor organizations to define the business areas within the enterprise handling the study. It should be noted that business therapeutic area is not the same as the therapeutic area defined in the StudyDesign class.

The Study class allows for 1 or more study designs to be included. This provides a single mechanism for master and umbrella studies. Multiple study designs are permitted so as to accommodate multiple designs that test multiple drugs and/or multiple cancer subpopulations in parallel under a single protocol without a need to develop new protocols for every trial. Typically, there would be a one-to-one relationship between study version and study design with 1 or more protocol versions related to the study covering the different designs. The studyDesign can refer to the study protocol version directly related to the specific design.

4.7 Study Identifiers and Titles

Study identifiers and titles are stored in separate dedicated classes as presented in the UML below and are referred to from out of the StudyVersion class.



The StudyVersion class allows for links to the 1 or more identifiers related to the study. Although multiple identifiers are permitted, they must be of 1 of 3 types: sponsor, registry, or regulatory authority. The study definition should have 1, and only 1, sponsor identifier but multiple other identifiers are permitted. Note the use of ISO 3166-1 country codes within the address field.

One or more study titles are required for a study. They can be of different types (e.g., official, scientific, short titles). If available, the acronym should be stored as a title as well, with specifying the type as acronym.

4.8 Study Design

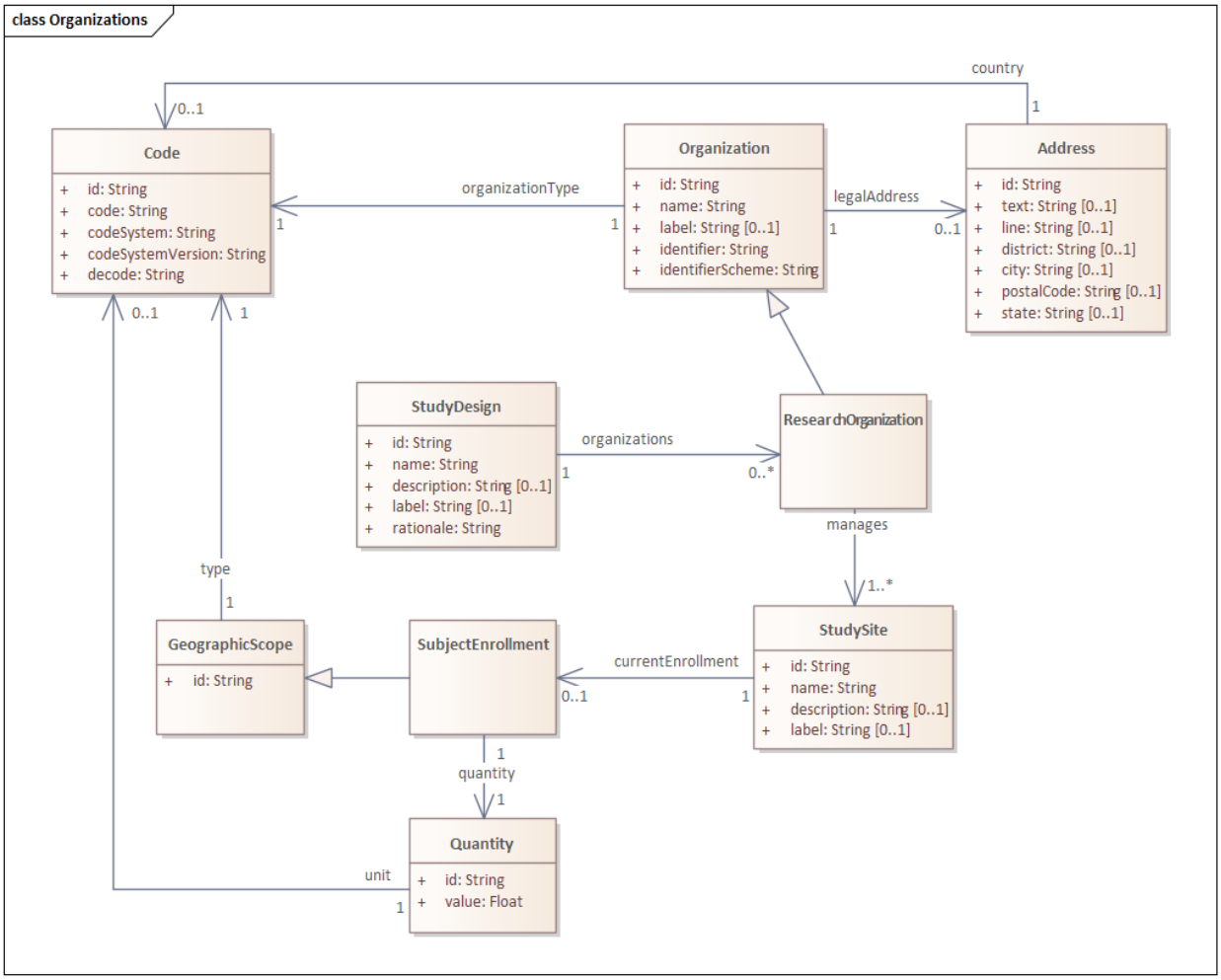
The StudyDesign class is the container for a single design within a study definition. It provides the slots for key parameters such as the trial type, trial intent type, blinding scheme, and intervention model. The class also provides a place to store 1 or more codes defining the therapeutic area to which the study design relates.

No controlled terminology is provided for the population of this therapeutic area field; the following table details controlled vocabularies that are available for users to populate 1 or more values into the attribute. A sponsor's own controlled terms can also be used.

Dictionary/Terminology	URL
EudraCT	https://eudract.ema.europa.eu/docs/technical/EUDRACT_Eutct_Pick_Lists_and_coded_values_v1_0.xls
ICD-10	https://www.icd10data.com/ICD10CM/Codes
MedDRA	https://www.meddra.org/
MeSH	https://www.ncbi.nlm.nih.gov/mesh/
NCI Thesaurus	https://ncit.nci.nih.gov/ncitbrowser/
SNOMED-CT	https://www.nlm.nih.gov/healthit/snomedct/index.html
US FDA	https://www.fda.gov/drugs/development-resources/spectrum-diseasesconditions

4.9 Organizations

Organizations are organizational entities that are involved in a clinical study. The organizationType identifies what kind of organization is specified (e.g., clinical study sponsor, clinical study registry, regulatory agency, research organization). A research organization inherits all attributes from the organization class and can manage 1 or more study sites. The scope of a study identifier can be an organization as well (see Section 4.7).



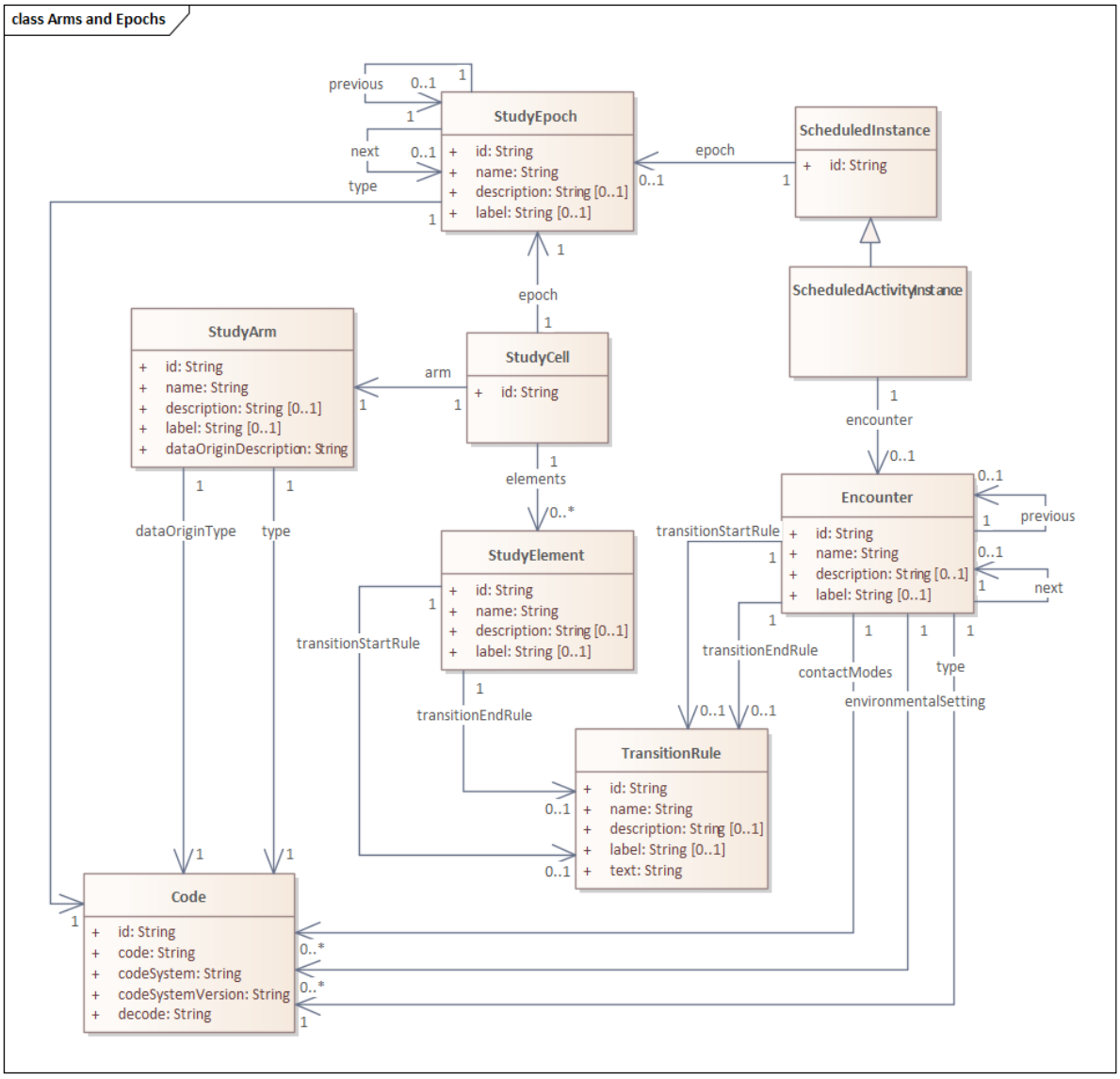
Research organizations are directly linked to the study design and indirectly via studyDesign to the corresponding study version and protocol document. If available, the number and/or percentage of subjects enrolled at time of the amendment can be specified per site. Study sites are managed by a researchOrganization.

4.10 Arms and Epochs

The high-level study design consisting of the arms and epochs is defined using the StudyArm, StudyEpoch, StudyCell, and StudyElement classes. The manner in which the classes are used follows the CDISC SDTM. Epochs are related to the study encounters (a more generic term for visits) via ScheduledInstances that form a ScheduleTimeline (for more information see Section 4.14, Study Timing). StudyElements can relate to the corresponding studyInterventions that are planned for the specific StudyArm and in the specific StudyEpoch.

StudyElements and Encounters have entry and exit rules that are defined using the TransitionRule class. It should be noted that although the StudyElements and Encounter classes share the use of the TransitionRule class, it is not expected that the instances within any study design will overlap; they are, most likely, distinct sets.

Given that the use of the classes is based on the SDTM, the information within these classes can be used to populate the SDTM Trial Design domains (see Section 7.1).

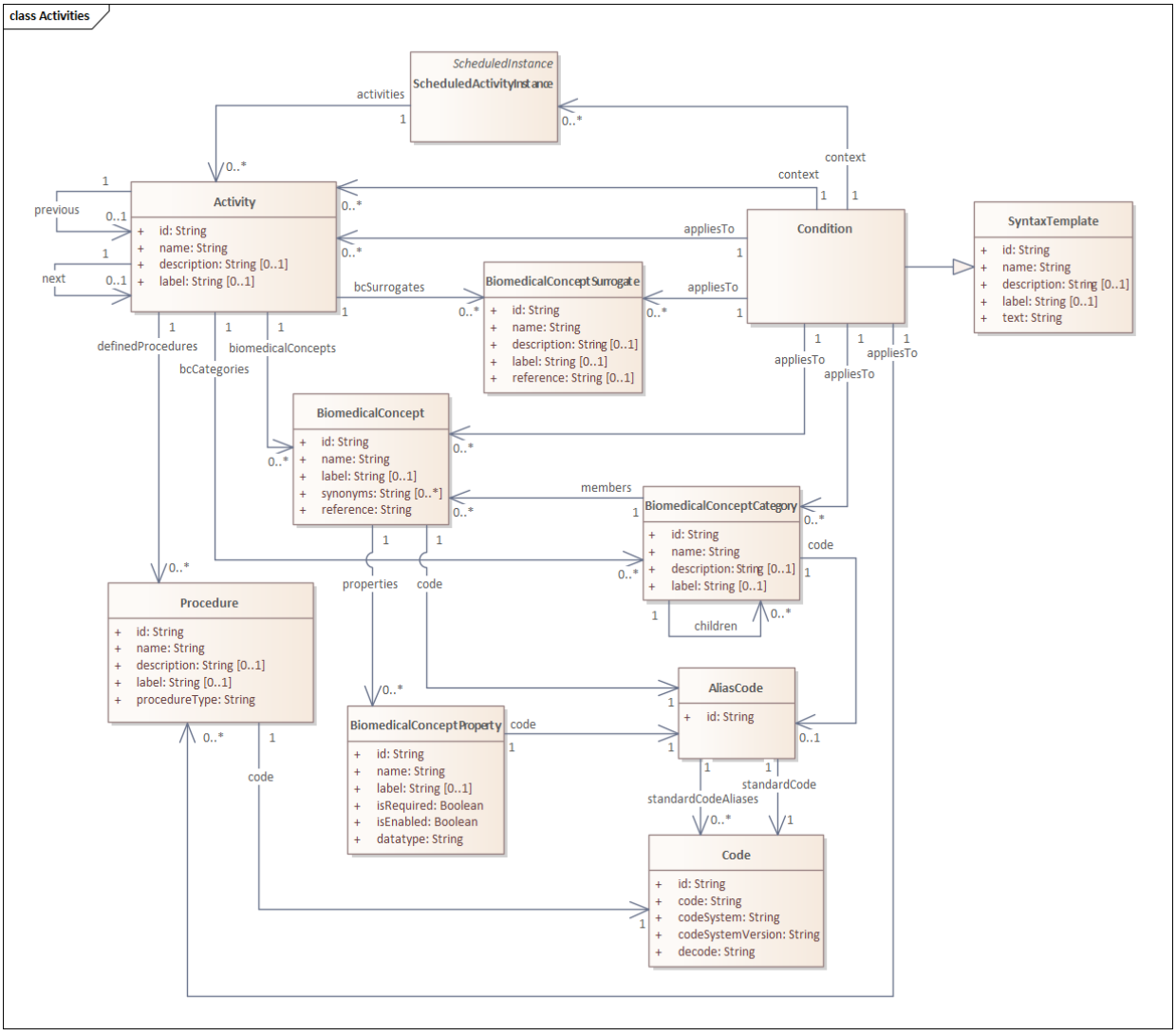


4.11 Activities

Activities are the means by which the procedures to be performed and the data to be captured are specified at a detailed level. The Activity class is used to group together data capture and procedures. The composition of these groupings is left to those designing studies and may align with the activities presented in the schedule of activities. Activities can be reused across multiple points within a study timeline via the ScheduledActivityInstance class (see Section 4.14, Study Timing).

The Activity class can be linked to 1 or more procedures (see Section 4.12), 1 or more biomedical concepts (see Section 4.13), 1 or more groups of biomedical concepts, and/or 1 or more surrogate biomedical concepts.

Activities or the corresponding assessments and procedures may be conditional. These conditions, specified in the Condition class, apply to at least 1 activity, biomedical concept, group of biomedical concepts, biomedical concept surrogate or procedure. The context of the condition can be to the activity in general (at every timepoint it is scheduled) or to a specific timepoint in the timeline via ScheduledActivityInstance.



4.12 Procedures

The procedures linked to the Activity class allow for the procedures required by the activity to be detailed. A procedure consists of a free-text name and description; procedures can be classified using a free-text type attribute

and coded using the code attribute. In cases where the procedure includes a study intervention (e.g., drug administration), the corresponding study intervention can be referenced.

4.13 Biomedical Concepts

The CDISC Biomedical Concepts model defines a clinical concept in a standardized and reusable manner; it is a specification focused on the data, not how the data are captured or processed. As such, biomedical concepts (BCs) are atomic entities and should not be split apart; to do so causes a loss of meaning. A BC is identifiable (has an identifier) and is complete (contains everything needed to use it).

A BC defines an observation but it requires context: the context of a clinical study. This is why, in the USDM, BCs are linked to activities and thus the remainder of a study design.

Within the USDM, the BC model has been represented in a manner consistent with the rest of the USDM. For example, controlled terminology references use the Code object to be compatible with all of the CT references across the USDM. Additional attributes have been added to allow for configuration as part of a study to enable or disable certain qualifiers or to constrain terminology responses to match the needs of a study (e.g., constraining units to metric values).

Note: Constraints can be applied to the content placed into the USDM but when those constraints are applied is not specified. A protocol may leave everything in the BCs unconstrained and only when deployment in capture systems happens will those constraints be applied.

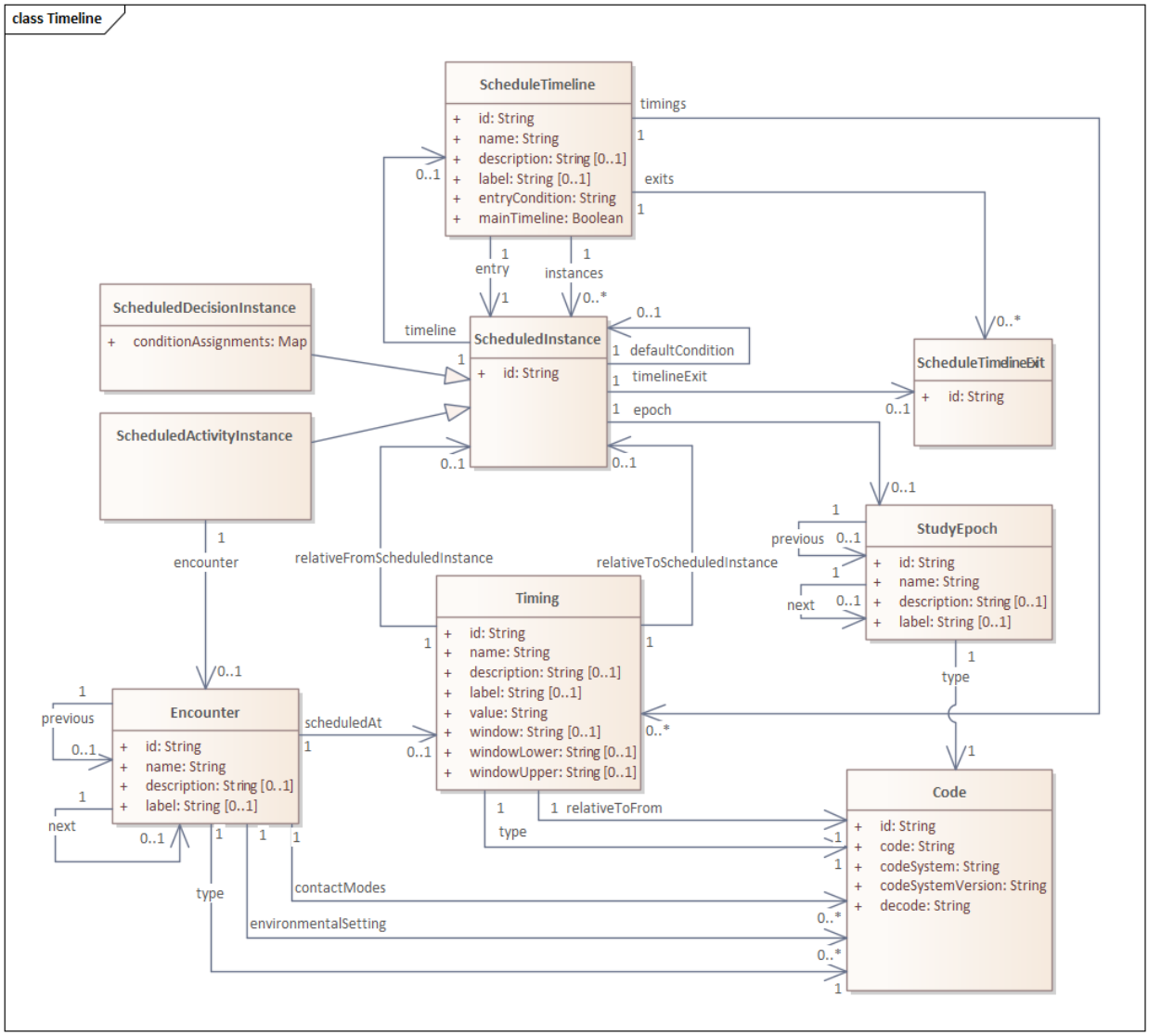
The USDM allows for the inclusion of a single BC (e.g., heart rate), a collection of BCs (e.g., vital signs preconfigured to include height, weight, heart rate, and other tests), or surrogate BCs. Surrogate BCs are a placeholder mechanism for when a BC definition is not available. This allows the name of a test to be specified but no further detail need be provided. Surrogates can contain a name and description pair for the concept required. A reference field is also provided to allow for links to reference materials (e.g., a URL for an external resource).

A single BC uses the BiomedicalConcept class as its root instance connected to 1 or more BiomedicalConceptProperty instances to define the various properties of the BC (e.g., result value, units, qualifiers). Some of the property nodes will require controlled terminology references; these are placed within ResponseCode instances which then onward refer to a Code instance holding the actual term reference.

One or more BCs can be grouped using a BiomedicalConceptCategory. It is assumed that, to be useful, more than a single BC should be added to a grouping such as the vital signs described above. These groupings are expected to be sponsor defined but, in the future, some can be expected to be industry defined.

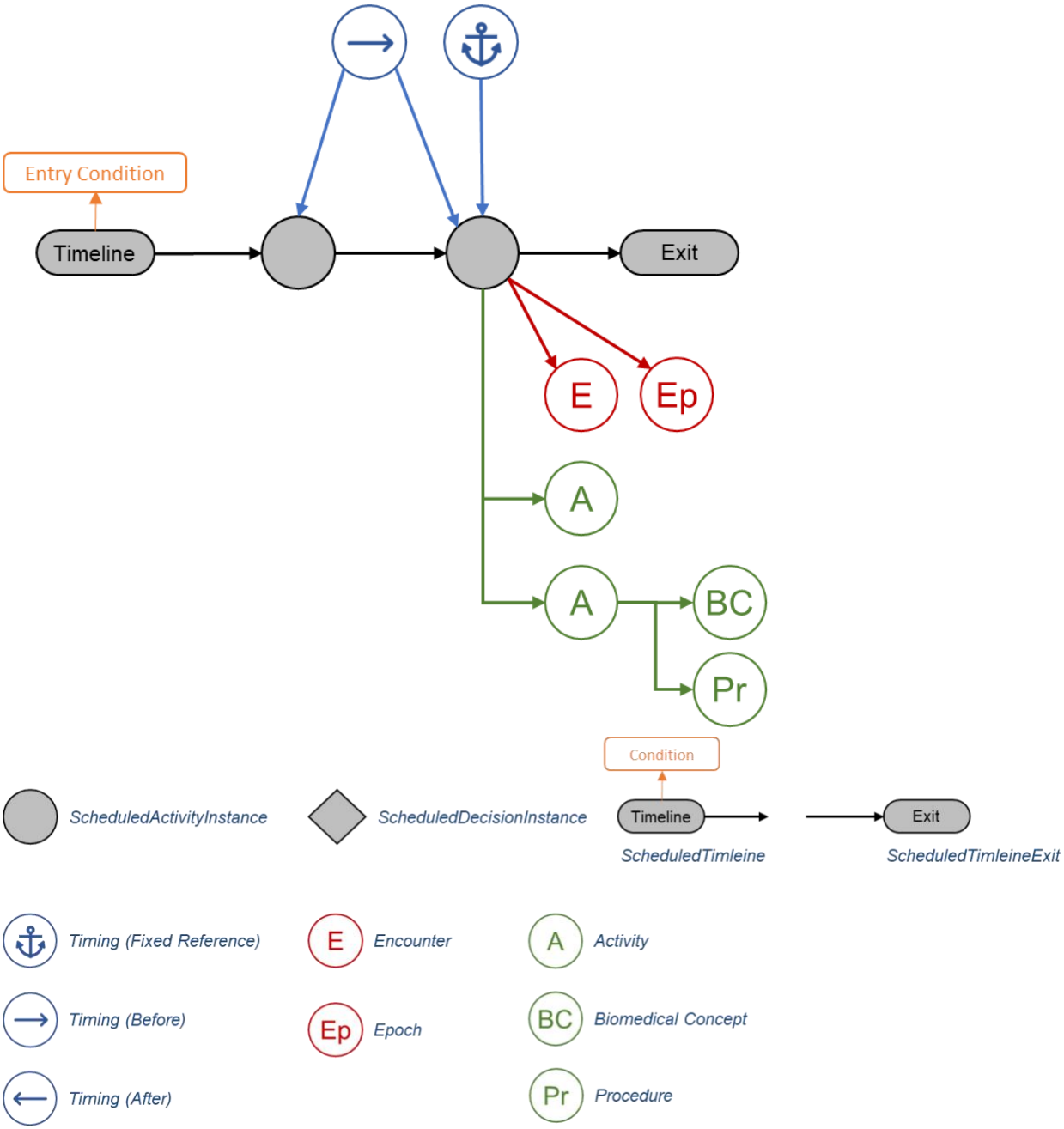
4.14 Study Timing

One of the key aspects of a study design is the timing of encounters (visits) and the activities to be performed within those encounters. The USDM includes a mechanism for building timelines that can be reused within a study and, given external library management, across studies. The corresponding classes and attributes are shown in the following UML diagram. This model allows for multiple planned timings within an encounter as well as for decision points in the study process. The corresponding information is stored in a timeline as scheduled activity instances and scheduled decision instances respectively. Both inherit all attributes and relationships from the ScheduledInstance class (indicated by the closed arrows in the UML) and can be linked to the corresponding study epoch. The Timing class includes all timing information with details on time between the Instances and corresponding windowing. One or more scheduled activity instance can be related to a corresponding encounter which is usually presented as a visit in the schedule of activities.



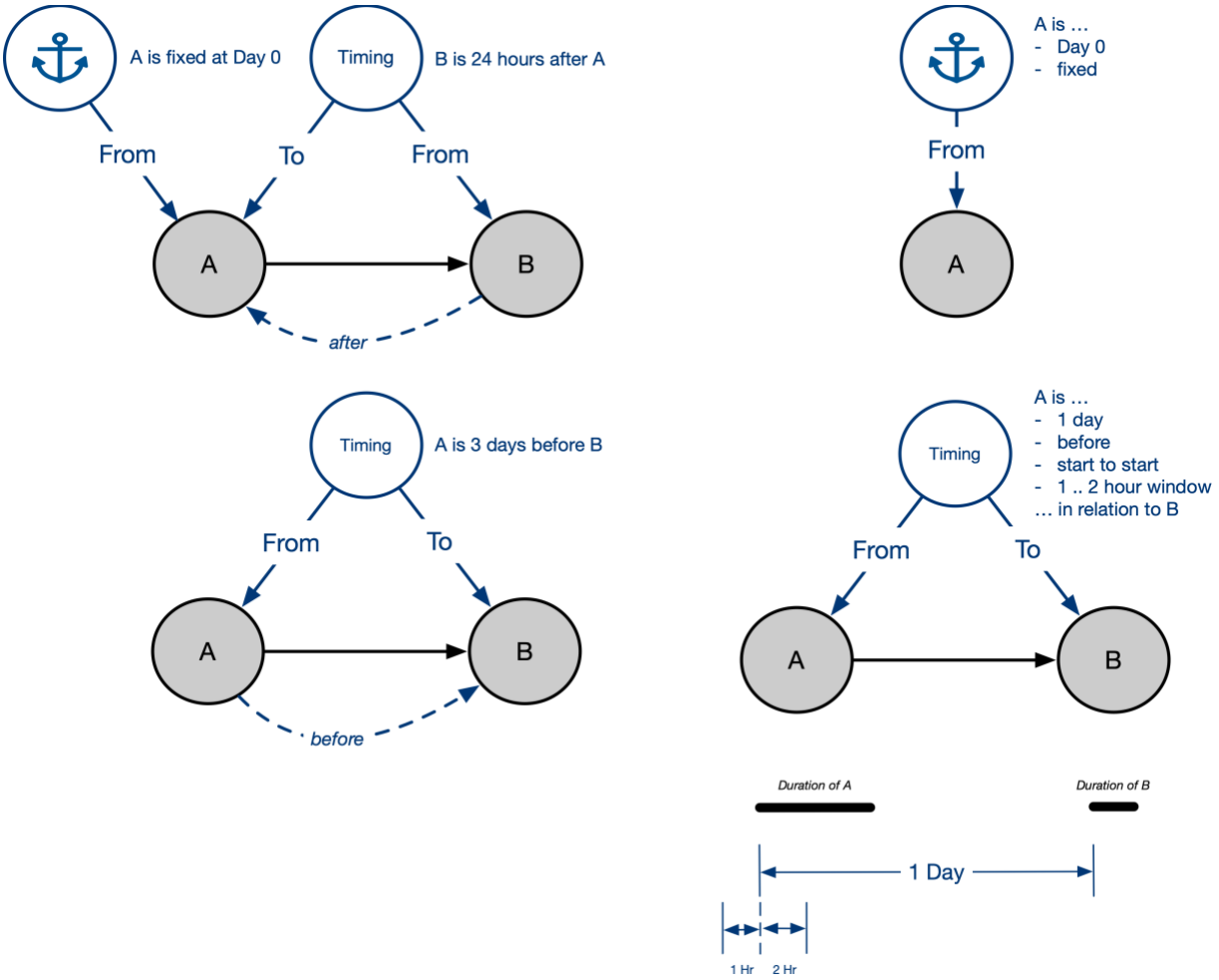
Timelines

The study timing mechanism depicted in the following figure is based on the notion of a timeline. A *timeline* is composed of an entry point with an associated entry condition (see ScheduleTimeline class), a sequence of steps (the ScheduledActivityInstance class and scheduledDecisionInstance class), timing relating the steps (the Timing class), and 1 or more exits (the ScheduleTimelineExit class). A timeline is named and can be referenced or reused within other timelines. The steps within a timeline link the encounters with the activities required for each step and thus define the timing for the encounters. The ScheduledActivityInstance class is the link between the high-level study design defined by the StudyArms and StudyEpochs classes, the Encounter classes, and the detailed study design defined by the Activity class.



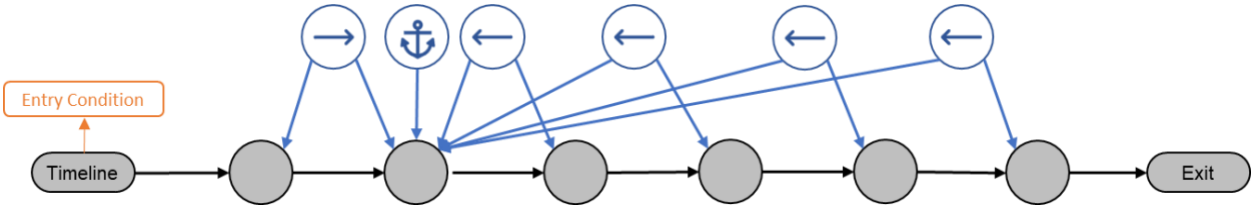
Timing

The timing between steps comprises a relative time of before or after, and an anchor time that is fixed. The following figure illustrates the timing capabilities. The Timing class allows for explicit timing to be built into a timeline using a combination of anchors (fixed timing) and relative timing.



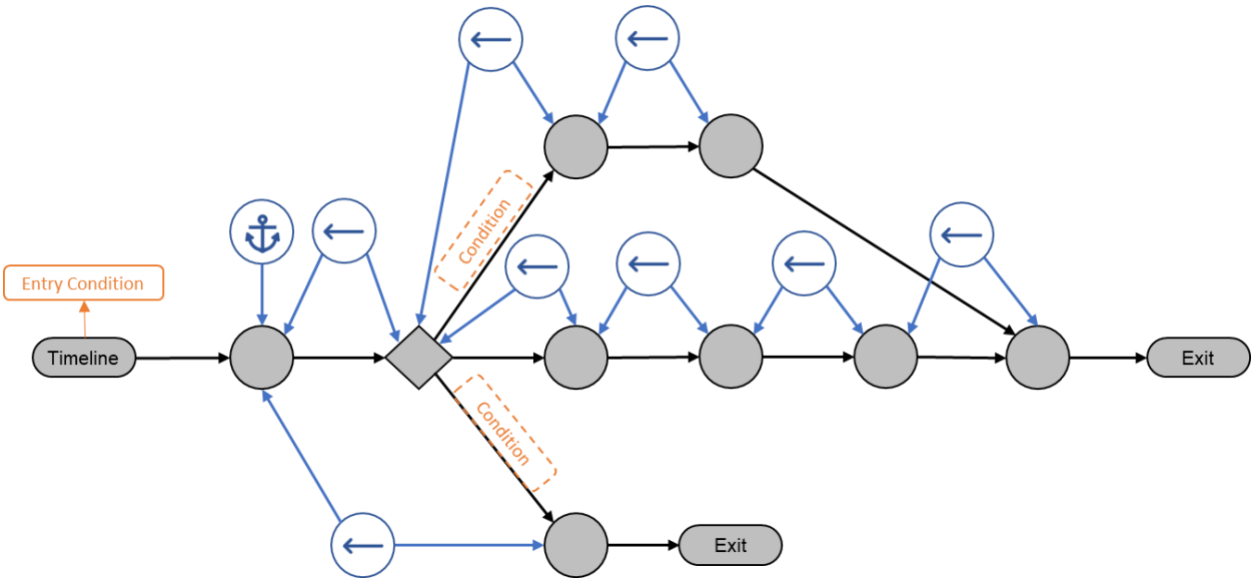
Planned timings are stored in the value attribute of the Timing class and are expected to be formatted according to ISO 8601. A corresponding window can be identified using the window attribute. The corresponding windowLower and windowUpper attributes are expected to be formatted according to ISO 8601 as well.

Note that timings can be defined between each consecutive scheduled instance or all or part of the timings can be related to a fixed (anchor) timepoint:

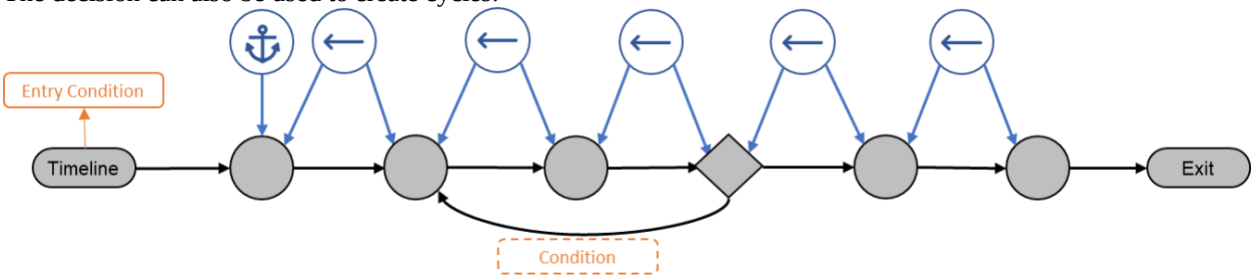


Decisions and Branching

Decisions and branching are handled using instances of the ScheduledDecisionInstance class within a timeline as shown in the following figure. Each decision point can handle multiple conditions; for example, simple yes/no decisions as well as a complex switch with multiple paths. Each possible route is set up with an associated destination. For switches, there should be a "default" condition specified for the case when none of the other conditions are satisfied.



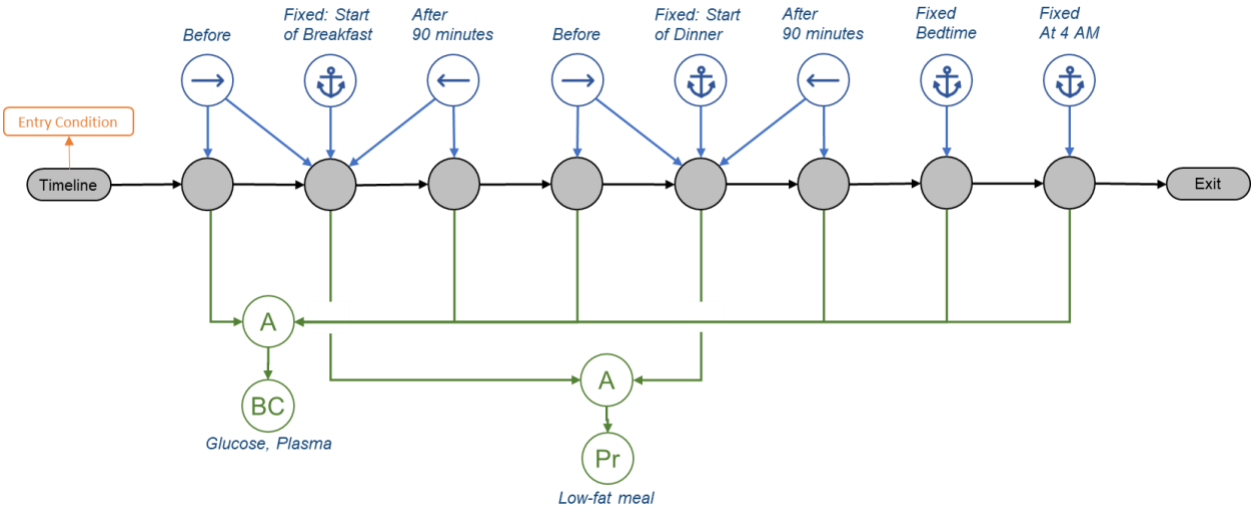
The decision can also be used to create cycles:



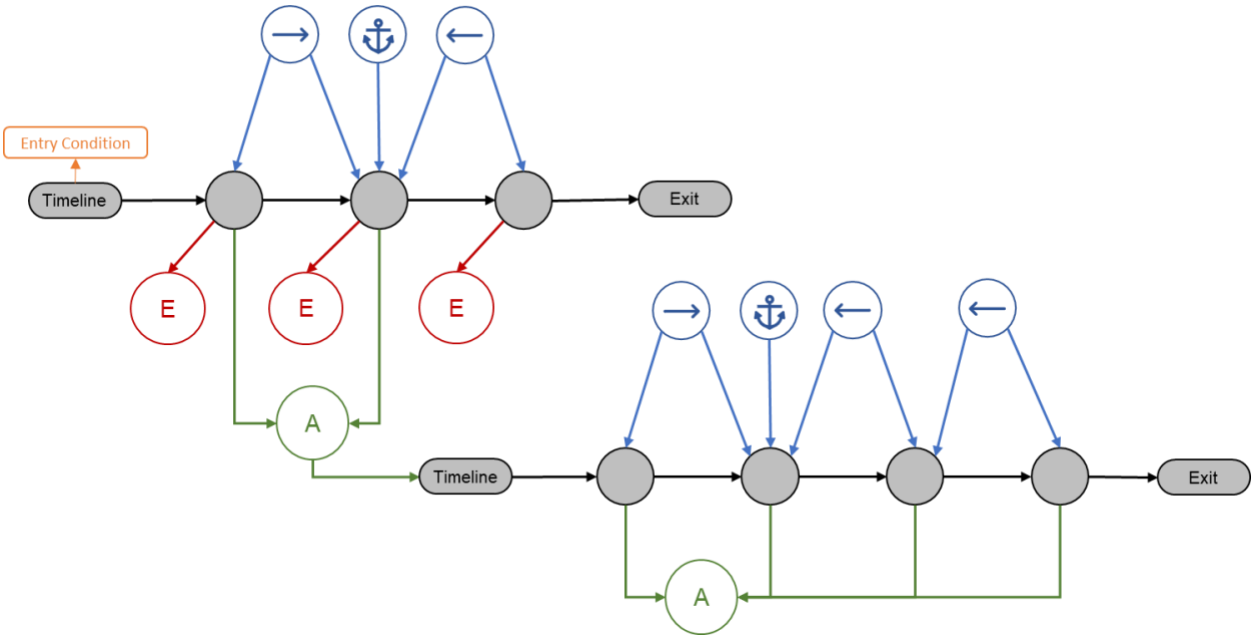
Descriptions of the decision and pointer are defined using the conditionAssignments attribute. This condition assignment is composed of 2 elements separated by a comma in the following order: a description of a condition and the id of the instance of the scheduledActivityInstance class that it points to once this condition is met, for example: "not reached cycle 12 and fulfilling eligibility to enter next cycle","ScheduledActivityInstance_2".

Profiles

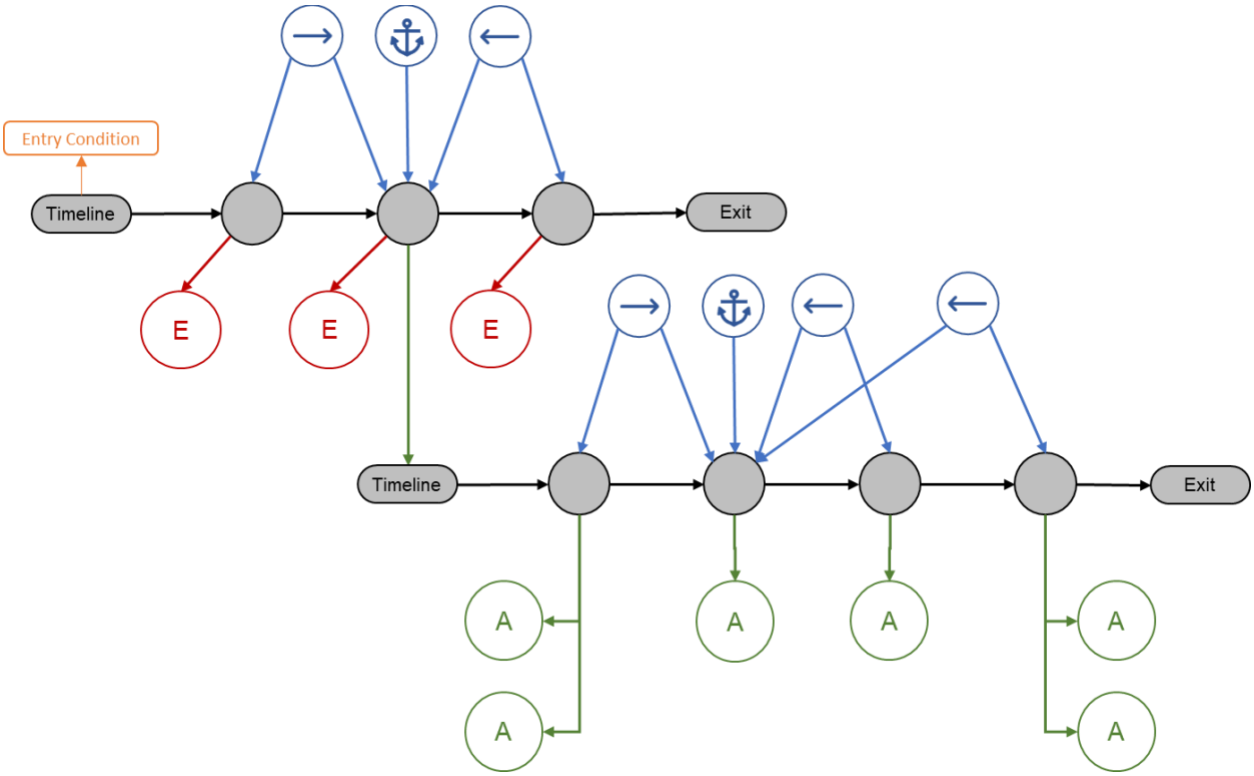
Profiles can be created using the various classes, as depicted in the following figure. A profile is another use of the timeline pattern and may reflect a sub-timeline within an encounter. A condition for entry can be defined but need not be. In this example, anchors are used to fix meal times over a single day and the associated observations scheduled in relation to the fixed mealtimes. The activities are shared across the steps within the profile.



The profile can be "attached" to an activity using the ActivityTimeLineId attribute so that it is executed as part of that activity, as illustrated in the following figure. This is useful for a sequence of repeated measures within the same activity.

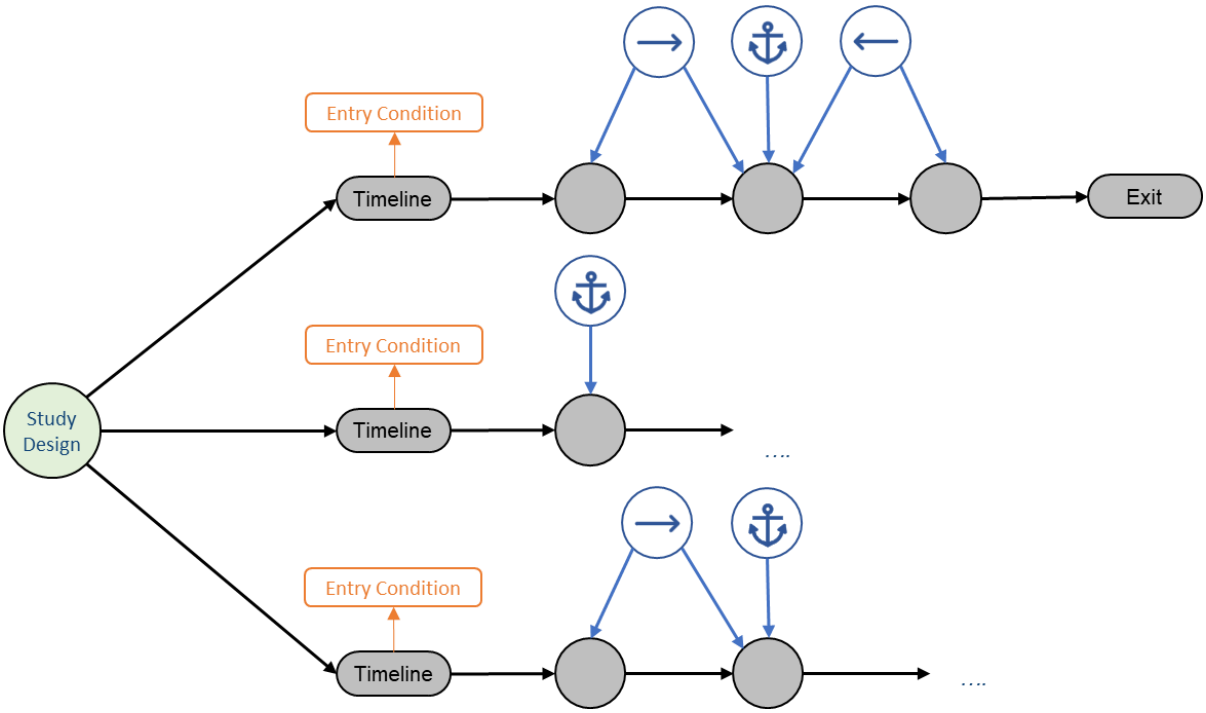


The timeline can also be attached to a ScheduledActivityInstance from another timeline using the timeline reference, thus allowing timepoints within a visit to be constructed, as shown in the following figure.



Unscheduled Visits

Unscheduled visits within a study are handled by creating separate timelines for each unscheduled "event" that needs to be handled within the study design. A study design would typically have 1 "main" timeline with a condition such as "subject identified". Further timelines can be created and linked to the StudyDesign instance with the timeline having an appropriate condition (e.g., "Adverse event", "Lost contact with subject"). Each timeline is then free to detail the steps taken under the respective circumstances.



Timeline Exit

It should be noted that the ScheduledTimelineExit instance does not perform any role other than marking the end of a timeline. It is linked from the last ScheduledActivityInstance instances in the timeline.

4.15 Indications

The indication for a study design can be placed into the Indication class. Each indication has a textual description plus the ability to define 1 or more codes from external code systems (including a sponsor's own terminology) that define the indication.

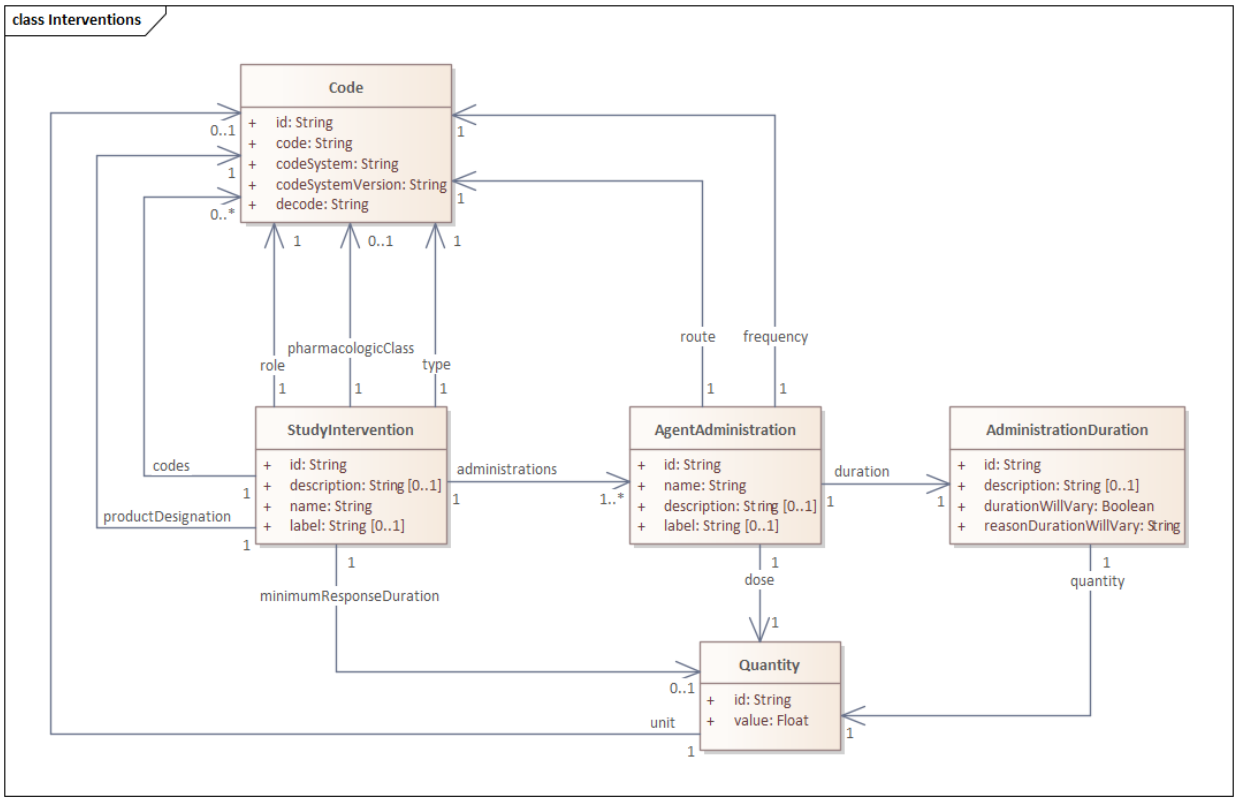
The attribute isRareDisease can be utilized to indicate whether an indication is regarded as a rare disease according to applicable rare disease registries (e.g., NIH GARD, Genetic and Rare Diseases Information Center).

4.16 Study Interventions

The interventions for a study can be placed into the StudyIntervention class. Each intervention needs to be defined by role, type, productDesignation, and administration details. Optionally, information on the pharmacological class, 1 or more codes from external coding systems, and the expected duration to minimum response can be added. The administration includes route, frequency, dose, and duration.

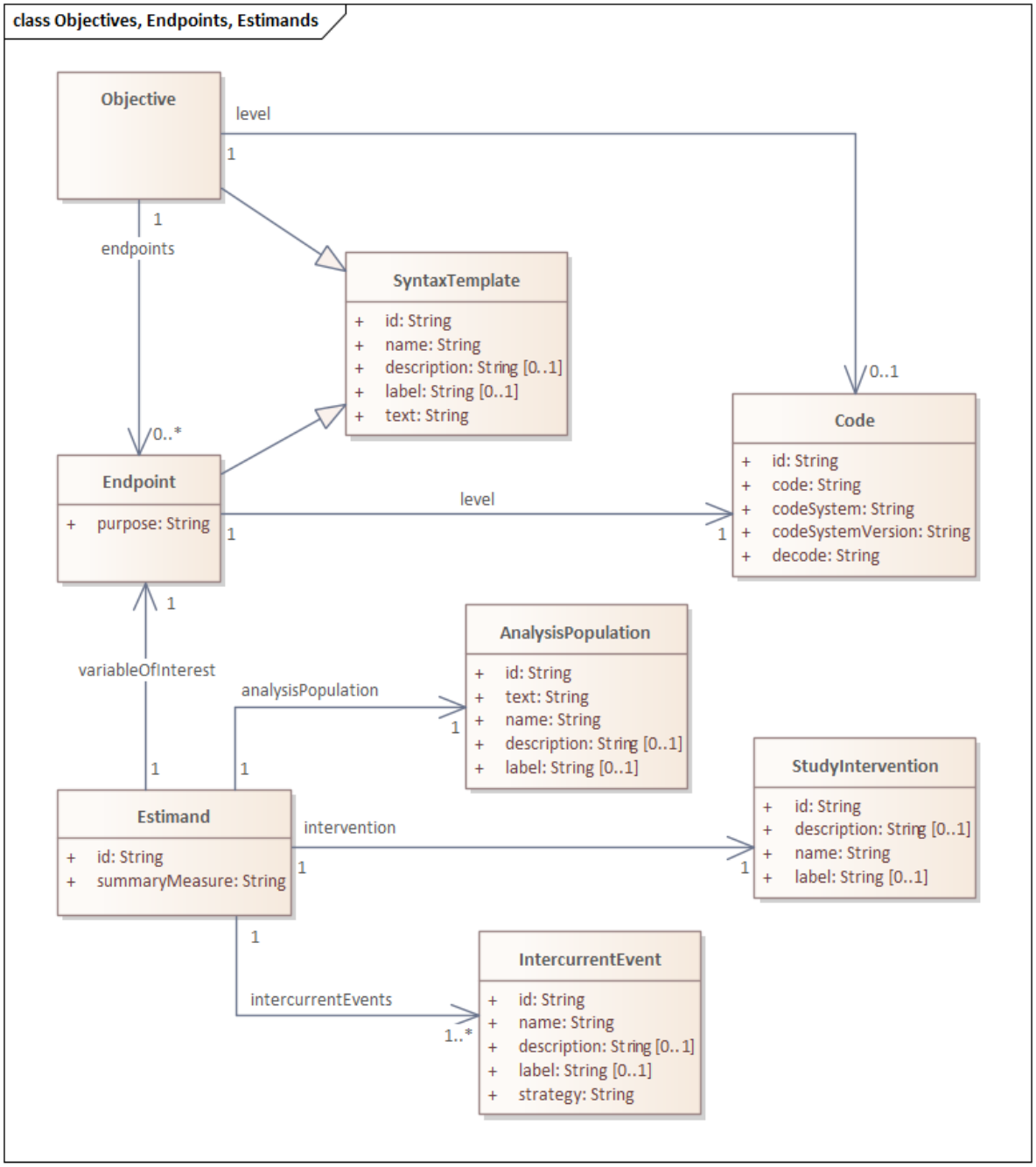
Note that the internal sponsor code or compound number for the drug can be stored as a code in the code class. This includes the reference to the codeSystem ("Sponsor Compound Code") and corresponding internal codeSystemVersion.

Study interventions need to be directly referred to from the Study Design class. In addition, they can be directly related to estimands, procedures, and study elements as defined for the corresponding classes.



4.17 Study Objectives and Endpoints

The study design objectives and endpoints can be defined within the Objective class and the Endpoint class. The Objective class allows for the textual description of the objective and its level (e.g., primary, secondary) and a link to 1 or more associated endpoints containing the endpoint definition in textual form. Both the objective and endpoint class inherit from the syntax template (see Section 4.21), allowing for references to information stored elsewhere in the data model. The endpoint may be a variable of interest for the study estimand (see Section 4.18).



4.18 Study Estimands

Aligning to the ICH guideline E9 (R1) addendum, study estimands and the definition of the treatments to be investigated, the population, the variable, and the handling of intercurrent events (ICEs) are handled within the Estimand, IntercurrentEvent, and AnalysisPopulation classes along with the relationships to endpoints (for the variable of interest; see Section 4.17) and study intervention (see Section 4.16) for the treatment.

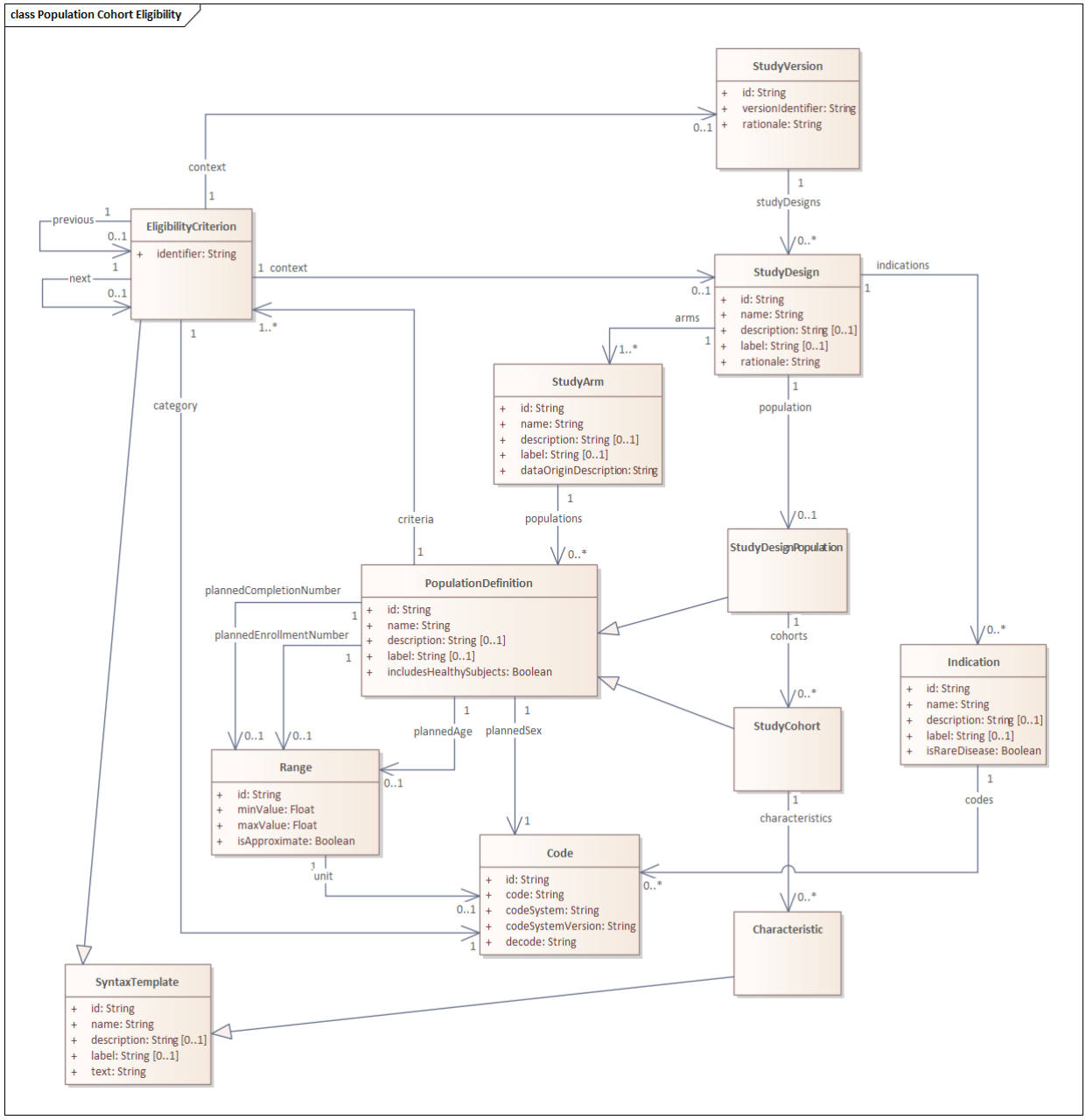
4.19 Populations, Cohorts and Eligibility Criteria

Population and cohort definitions define a (sub-)group of subjects that take part in the study. The parent class PopulationDefinition is used to define a group of patients in general. This class includes references to the eligibility

criteria that are applicable to this population. All the elements of the PopulationDefinition class are inherited by both the StudyDesignPopulation class, which stores the population details for a specific study design, and the StudyCohort class, which stores the details of subpopulations that, based on their characteristics, may deviate in how they are treated, assessed or analyzed.

In addition to the inherited attributes from the PopulationDefinition class, the StudyDesignPopulation class may refer to the corresponding subgroups stored as study cohorts; the StudyCohorts class may refer to additional characteristics not defined by any of the other attributes in the PopulationDefinition class. These characteristics are stored in the Characteristic class, which inherits its attributes from the Syntax Template class (see Section 4.21) and can thus refer to any item stored elsewhere in the USDM.

Eligibility criteria inherit from the Syntax Template class as well, allowing for referencing any item stored in the USDM, such as assessments stored as BCs or an indication stored in the Indication class. The context of each eligibility criterion should be indicated either by a reference to the whole study (StudyVersion class) or to a particular study design (StudyDesign).



4.20 Unstructured Content

Study protocols include content that is best described as "unstructured content," granting the author considerable flexibility in determining what information to include, the level of detail it will contain, the order in which it is introduced and discussed, and how it will be presented. Blocks of unstructured content can range from short text statements to many paragraphs which may also contain figures and tables.

The Narrative Content class in the UML is modelled to contain such blocks of user-defined unstructured content using HTML format. The recursive nature of this class provides the user the ability to add multiple named blocks of unstructured content, allowing for a hierarchy of related information to be built up and ordered by the Section Number attribute.

The HTML format and section ordering (facilitated by the attribute sectionNumber) provides the capability for organizing the information in a way that is compatible with any required document structure such as ICH M11,[4] the TranCelerate CPT, or a sponsor's internally defined template.

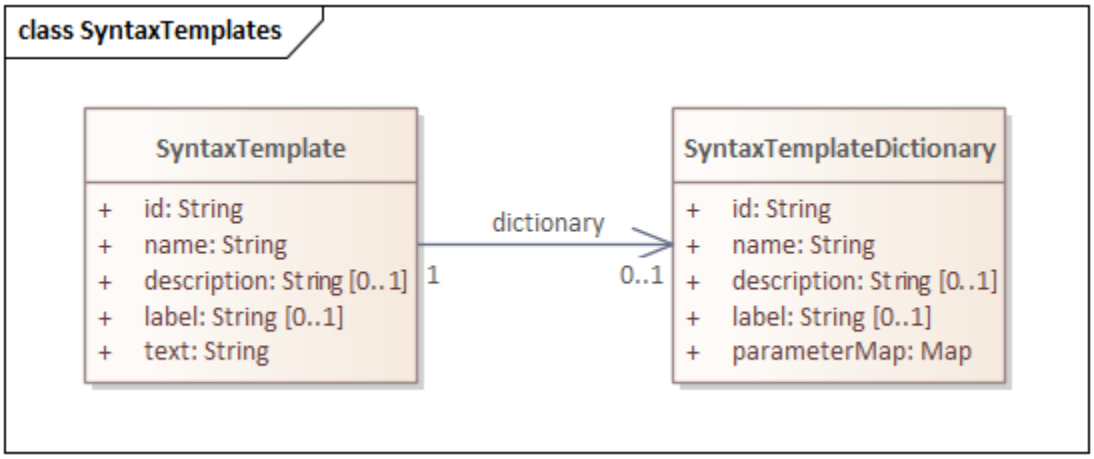
4.21 Syntax Templates

With syntax templates, human-interpretable plain text sentences are structured and linked to structured items held elsewhere in the USDM data model. Examples of items typically represented in protocols as plain text that we wish to structure are:

- Endpoints that can be linked to a corresponding assessment and timing
- Objectives that can be linked to corresponding interventions and indications
- Eligibility criteria referring to an indication, a population, minimum and maximum age, and/or 1 or more assessments
- Conditions that can be linked to a corresponding BC or indication
- Cohort characteristics that can be linked to corresponding BCs or indications

Links are achieved by inserting parameters into the plain text that replace specific parts of this text. The same parameter can be reused multiple times in different text templates, which allows for consistency throughout the study design. Structuring text in this manner allows for the text to be more readily processed in downstream systems. Moreover, by using standard structured text, consistency across studies can be increased by allowing for reuse, which results in easier comparison and performing meta-analyses.

The syntax templates classes are presented in the following UML.



The attributes and relationships of the SyntaxTemplate class are inherited by any class reusing its capabilities (e.g., Endpoint, EligibilityCriteria, Characteristic). The text attribute stores the structured text of the corresponding endpoint, criterion, or characteristic. The content of this attribute is HTML based to allow for for formatting and proper referencing to data elements that are specified in the associated SyntaxTemplateDictionary class. This syntaxTemplateDictionary class holds the mapping between the references seen in the text attribute of the SyntaxTemplate class to a reference of content held elsewhere in the data model. Instead of reference to an attribute stored elsewhere in the model, for digitizing and standardization purposes, fixed values are allowed as well in the parameter mapping.

To point exactly to this content, the parameterMap in the SyntaxTemplateDictionary class is structured as a list of references with the following format:

paremeterMap format
<*parameterName*,*ReferenceClassName*(id=*ReferenceClassId*).*ReferenceAttributeName* | *fixedValue*>

in which

parameterName is the name that is given to the parameter that can be (re-)used in the text attribute of the classes inheriting from SyntaxTemplate.
ReferenceClassName is the name of the class that holds the referenced data element.
ReferenceClassId is the id value of the referenced data element within *ReferenceClassName*.
ReferenceAttributeName is the attribute name of the referenced data element within *ReferenceClassName*.
fixedValue is a fixed value that can be referenced and reused instead of a reference to content held elsewhere in the data model.

Some examples of references are:

```
<PrimaryOutcomeMeasure,BiomedicalConcept(id=011).description>
<PrimaryOutcomeTiming,Timing(id=3232).label>
<IMP,StudyIntervention(id=1212).description>
<RefHbMax,7.0>
```

The parameters that are specified in the parameterMap attribute (like PrimaryEndpointEndpointTiming,IMP and RefHbMax above) can subsequently be referenced in the text attribute of the syntaxTemplate and thus is all classes inheriting this.

The corresponding structure for referencing to these parameters is:

parameter referencing
<usdm:ref id="*parameterName*">

The following is an HTML example for an endpoint referencing the corresponding outcome and timing:

```
<div><p><usdm:ref id="PrimaryOutcomeMeasure"> after <usdm:ref id="PrimaryOutcomeTiming"> of administration of
<usdm:ref id="IMP"></p></div>
```

4.22 Addressing Footnotes

Information represented by footnotes in a schedule of activities (SOA) can be stored structurally in the USDM and as such can be parsed and presented as footnotes when feasible. By using this computer-readable format, the often complex and extensive footnote information is more usable for downstream processes. This section describes the following different types of footnotes that may be identified in SOAs and how they can be stored in the USDM:

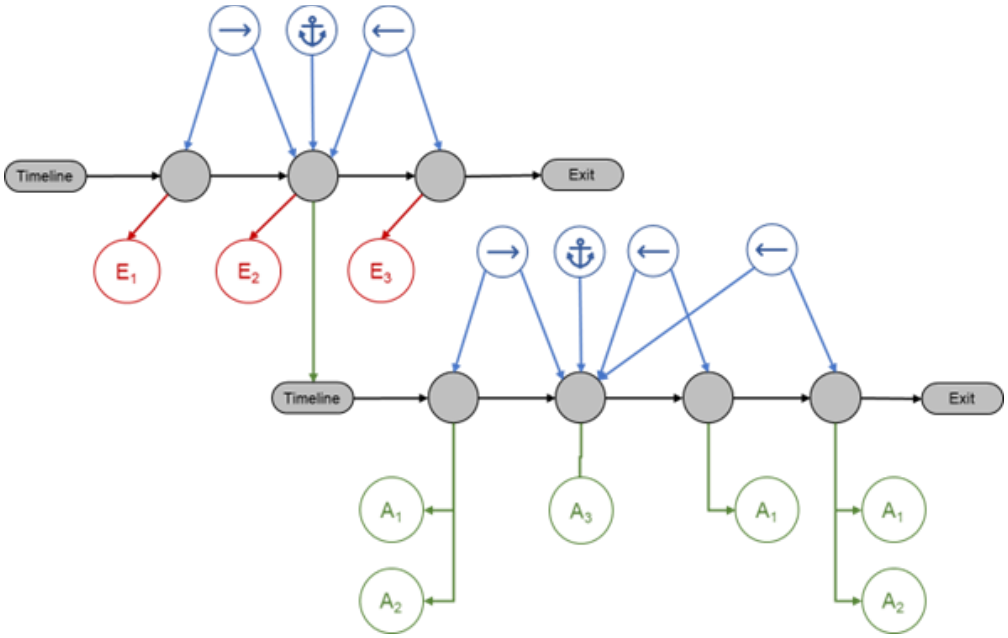
- Footnotes representing sub-timelines
- Footnotes representing timing and/or order of activities
- Footnotes representing alternative visit schedules
- Footnotes representing conditional activities, assessments, and procedures
- Repeated activities not presented in the SOA
- Footnotes representing optional alternative encounter methods
- Footnotes representing measurements to be done for a specified activity
- Footnotes representing optional alternative measurement methods
- Additional instructions for procedures and/or performing assessments
- Visit and timing window information
- Eligibility requirements
- Complex combinations

Footnotes Representing Sub-timelines

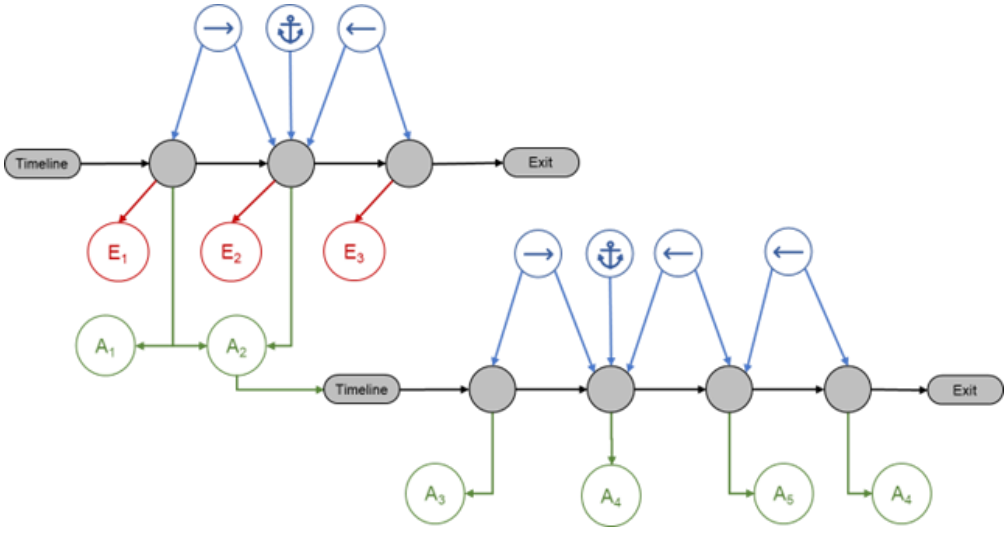
These footnotes indicate at what exact timepoints activities not presented in the SOA should be performed, for example:

1. Blood samples for … predose, 1h, 24 h, …
2. X assessment to be performed predose and at 40 minutes and 1.5h postdose
3. Measurement after 5 minutes in supine position and after 3 minutes in standing position

In case of assessments relating to dosing (examples 1 and 2), individual timepoints can be stored as ScheduledActivityInstances forming together a sub-timeline (see following diagram). This sub-timeline is referred to from a ScheduledActivityInstance on the main timeline. The time relationships (->, <- in the diagram) of these instances will be defined using the corresponding Timing classes. The timing related to the instance for the dosing activity (A_3) is defined as the anchor. Activities such as pharmacokinetic samples (A_1) and vital signs measurements (A_2) can then be added as needed, reflecting the correct timings related to dosing. Sub-timelines can be reused across multiple ScheduledActivityInstances on the main timeline.



In case of an assessment sequence relating to 1 activity (e.g., repeated blood pressure measurements in different positions), a sub-timeline can be directly referenced from the corresponding activity using the timeline relationship in this class (see following diagram). The activity A_2 (e.g., vital signs), refers to the sub-timeline indicating the corresponding positioning and assessment actions. For example, put subject in supine position (A_3), assess blood pressure (A_4); put subject in standing position (A_5) and repeat the blood pressure assessments (A_4). The timings in between are defined by the information in the corresponding Timing class.



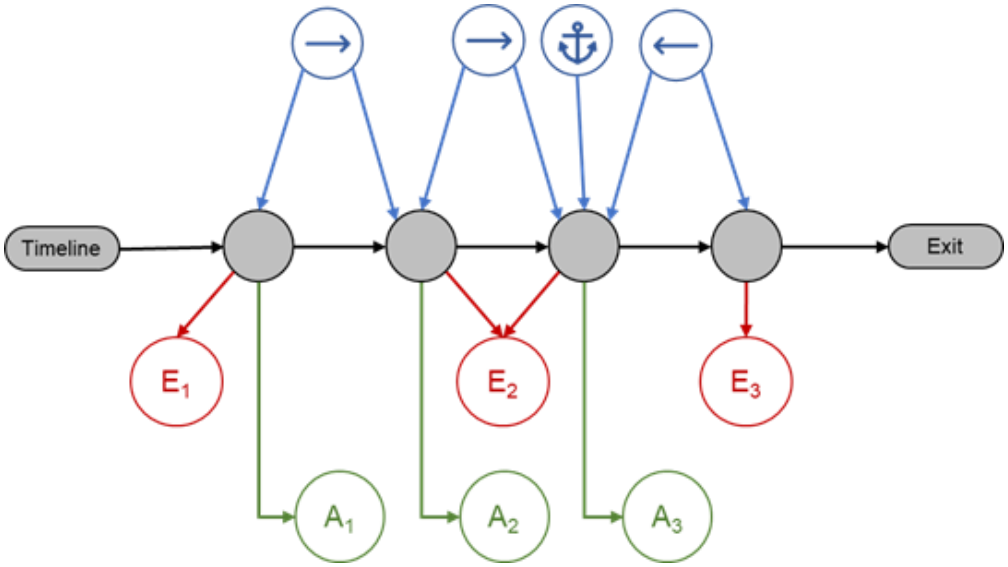
See Section 4.13, Study Timing, for more information on timelines.

Footnotes Representing Timing and/or Order of Activities

These footnotes indicate an order of activities and what should be done first, for example:

1. Informed consent must be obtained prior to any study-related procedure
2. Assessment X should be done before all other ….
3. Assessments to be done on day of admission

A simple sequence of 1 activity or groups of activities can be represented by separate instances of the scheduledActivityInstance class in the main timeline pointing to the same encounter. For example, in the following diagram, encounter E2 includes 2 scheduledactivityInstances. The first one links to activities that need to be done prior to any other activity (e.g., informed consent) and the second scheduledActivityInstance relates to all other activities that are required during that encounter.

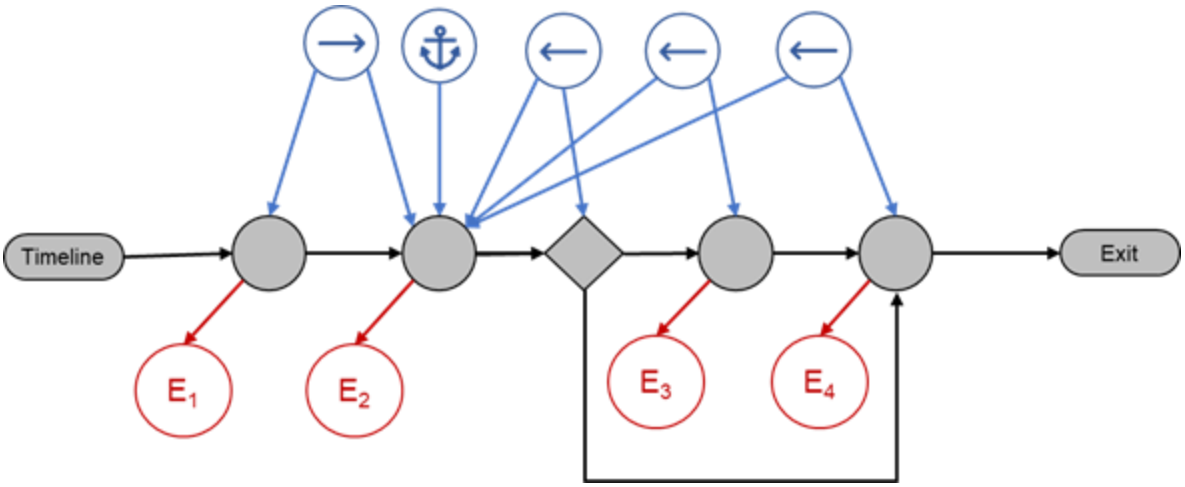


Footnotes Representing Alternative Visit Schedules

These footnotes indicate optional alternative visits based on conditions, for example:

1. Visits in case of events, inability to continue, or withdrawal (early-withdrawal visit)
2. An additional optional period of up to 3 weeks is permitted
3. Visits can occur on same day if no additional period is needed

To optionally add a visit, a scheduledDecisionInstance needs to be added to the timeline. Apart from the default next step in the timeline (defined by a defaultCondition), this scheduledDecisionInstance includes a condition and corresponding alternative next step that can be defined. In the following diagram, encounter E_3 is skipped when the condition is met. This condition as defined in the attribute conditionAssignments could then be “inability to continue”, “subject withdrawn”, or “no optional period of 3 weeks”.



Example 3, visits occurring on the same day, is more complex. Visits can optionally be combined; the ScheduledDecisionInstance needs to be set to "no additional period needed?" If yes, then the next visit (E_3) can be skipped. In cases where activities were planned at this skipped visit E_3 (and not at the previous visit E_2), these should be added to the previous visit E_2 with the conditionality that they only need to be done when the next visit is skipped.

Footnotes Representing Conditional Activities, Assessments, and Procedures

These footnotes indicate conditions for a specified activity to be performed (or not), such as:

1. Assessments only for women with childbearing potential
2. At the discretion of the investigator
3. Assessments only if within *x* days after *y*
4. Only in case of extra wash-out needed; all others to perform assessment at end of week *x*
5. Discharge after criteria for discharge are met
6. Only if dipstick urinalysis is positive
7. Assessment to be done every 3 cycles
8. Only for subjects electing to participate in the additional substudy
9. If needed

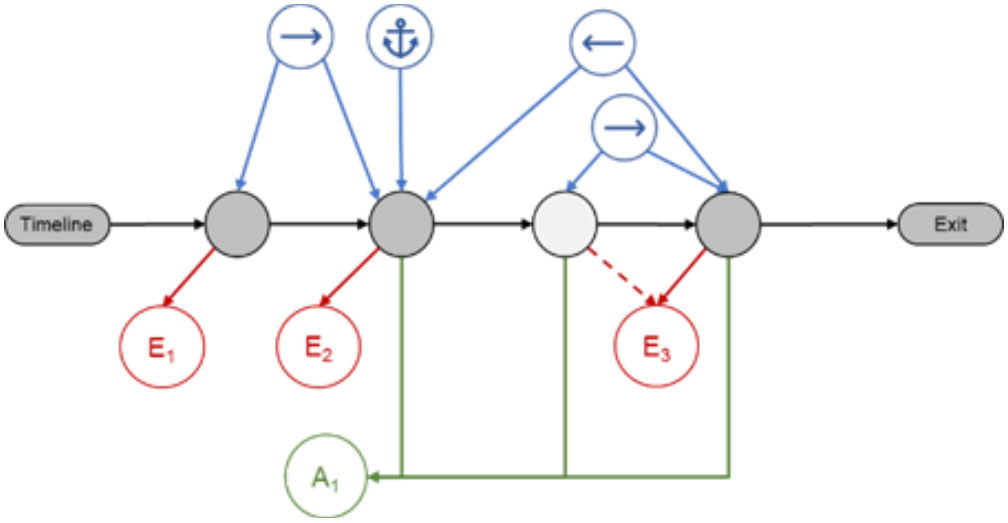
These footnotes can be stored in the Condition class. The footnote text is stored in the text attribute and can optionally link to other elements stored in the USDM as described for syntax templates (see Section 4.21). Each specified condition in this class applies to the whole activity, a BC, a BC category, a BC surrogate, or a procedure. The context indicates to what part of the SOA it applies. This relates to where the footnote indicator is placed in the SOA. A footnote directly linked to the activity description is applicable for all occasions of that activity and should therefore have the context related to that activity. If the condition holds for a specific timepoint of that activity, then the context should be set to the corresponding scheduledActivityInstance to indicate when it is applicable. See Section 4.11, Activities, for more information.

Repeated Activities Not Presented in the SOA

These footnotes specify activities that are not directly presented in the SOA because they need to be done in between regular visits, for example:

1. Questionnaire will be filled in every 2 weeks until …
2. During run-in period, patients will perform XX measurements and inhale placebo medication at approximately 12-hour intervals for a minimum of 14 days and maximum of 21 days.

The first step in mapping these activities is to identify instances where they do not match the regular encounters represented in the SOA. These instances need to be added as ScheduledActivityInstances to the timeline with the corresponding timing information. The implementer can choose to create a separate encounter for them or to link them to the last or next encounter as required by the implementation and downstream processes (e.g., EDC setup).



Footnotes Representing Optional Alternative Encounter Methods

These footnotes specify potential encounter methods, such as:

1. Performed by telephone by qualified staff
2. If regularly allowed, visits may take place at home

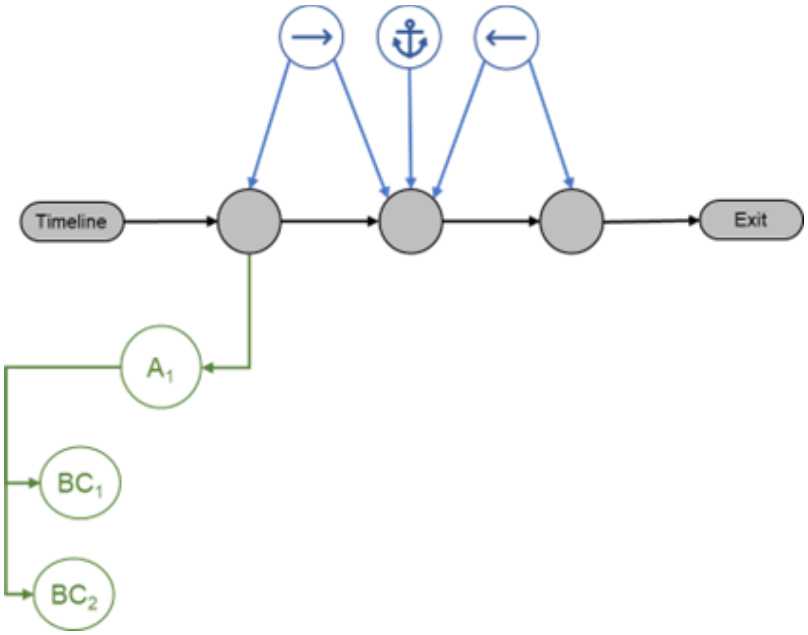
The encounter methods are specified by the attributes environmentalSetting and contactModes in the Encounter class. More than 1 contactMode may be entered if optional alternative encounter methods are allowed.

Footnotes Representing Measurements to Be Done for a Specified Activity

In most protocols the exact assessments to be done are specified in dedicated paragraphs. However, in some cases, they are specified in the footnotes of the SOA, for example:

1. Hematology must include CBC with differential including but not limited to ….
2. T/B/NK cell count (i.e. CD3, CD4, CD8, CD19, CD16/56)

These assessments can be specified as BCs and linked to the corresponding SOA activity as shown in the following diagram.



Footnotes Representing Optional Alternative Measurement Methods

These footnotes indicate more than 1 alternative for an assessment, for example:

1. Diagnosis confirmed with either chest x-ray or CT scan
2. Urine or plasma pregnancy test

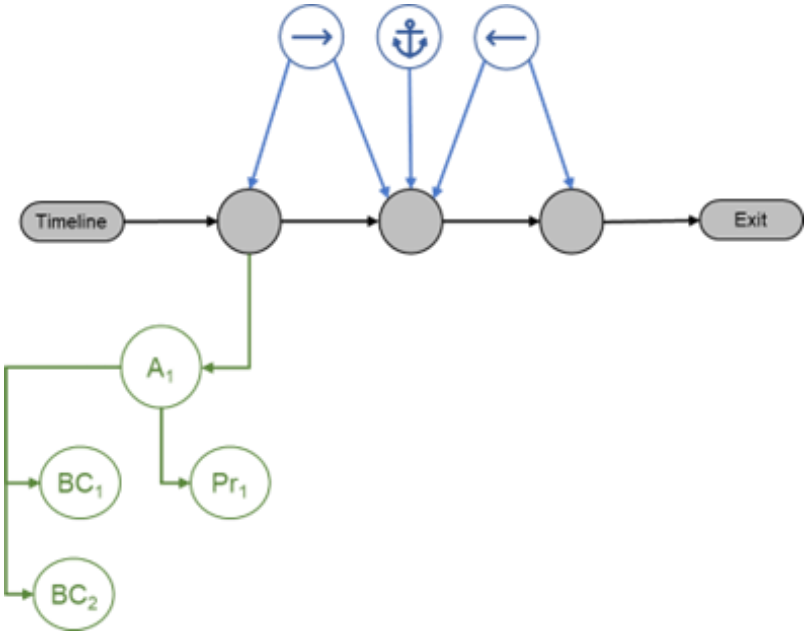
As with conditional footnotes, these footnotes can be handled using the Condition class. The text can then be stored in the corresponding text attribute. Both assessments need to be specified as a BC, procedure, or BC surrogate. The specified condition then can be related to both using the appliesTo relationship.

Additional Instructions for Procedures and/or Performing Assessments

These footnotes give details on how assessments need to be done, for example:

1. A ruler will be provided to assess …
2. Samples will be sent to …
3. Subjects should adhere to low-fat diet on day of sample collection
4. In order to assess *y*, the add-on medication should be continued for at least *x* weeks
5. X will be assessed by a blinded assessor
6. Patients should be instructed to use the inhaler in the morning at approximately the same time

Depending on the nature and level of instruction, this can be included in the BC when directly related to a specific assessment or added as a procedure (Pr_1) to the same activity as illustrated in the following diagram.



Visit and Timing Window Information

Visit window information is often shown in the column header of the corresponding visit, but in some cases may be added as footnotes; for example:

1. Assessments need to be done within 10 minutes after dosing
2. Visits need to take place between 5 and 10 days after dosing

As explained in Section 4.14, Study Timing, all specific groups of activities that occur at a specific timepoint are stored as separate scheduledActivityInstances and are linked to the corresponding timing. This timing class has attributes that can be used to specify the timing window. The window attribute is used to store the textual value of the window (e.g., "within 10 minutes after dosing") whereas the windowLower and windowUpper attributes are used for the computer readable version in ISO 8601 format (e.g., "T0M", "T10M").

Eligibility Requirements

Eligibility criteria are stored in the EligibilityCriteria class (see Section 4.19, Populations, Cohorts, and Eligibility Criteria). In some cases they are repeated in the SOA; for example::

1. Screening spirometry must demonstrate a value of …. In the morning of the first day of treatment value must also be in range
2. Patients must demonstrate >= 15% reversibility of FEV1 within .. following inhalation of …

The EligibilityCriteria class uses text templates for the specifications of the criteria. Using these text templates, criteria can refer to the corresponding activity or assessment (BC) in the SOA. If required, these cross-references could be used by an implementation to link the criteria to the SOA and present them with the corresponding activities in the SOA.

Complex Combinations

Footnotes are often complex, long text that includes different kinds of requirements (e.g., a combination of timing, duration, conditionality, and/or methods), such as:

1. All subjects will perform a X profile for any 3 days (not required to be consecutive) during week (-2) to week (01), week 11-12, week 23-24 and week 51-52. Blood glucose readings will consist of 3 preprandial measurements (1-15 minutes before breakfast, 1-15 minutes before lunch, and 1-15 minutes before dinner)

AND 3 postprandial measurements (1~1-2 hours after breakfast, 1~1-2 hours after lunch, and 1~1-2 hours after dinner).) The initial preprandial 6-point glucose measurement on the *x* day should be a fasting plasma glucose reading.

2. SpO2 before activity (baseline), during activity until the end of anaesthesia, and during postoperative recovery

For the purpose of comprehensibility of the SOA and for consistency throughout the study process, it is helpful to deduct the separate requirements from these footnotes and digitize them according to the solutions presented in this section.

5 USDM Data Dictionary

Note: Properties without a description in the following table are either relationships or instance identifiers and were deemed to be out of scope for terminology development. Please see Section 4.4, Internal Identifiers Within the Model, for additional information on the use of identifier variables in the model.

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
Activity			C71473		Study Activity	An action, undertaking, or event, which is anticipated to be performed or observed, or was performed or observed, according to the study protocol during the execution of the study.		
	id	string						
	name	string	C188842		Clinical Study Activity Name	The literal identifier (i.e., distinctive designation) of the clinical study activity.		
	description	string	C70960		Clinical Study Activity Description	A narrative representation of the study activity.		
	label	string	CNEW		Activity Label	The short descriptive designation for the activity.		
	definedProcedures	Procedure		0..*				
	biomedicalConcepts	BiomedicalConcept		0..*				
	next	Activity		0..1				
	timeline	ScheduleTimeline		0..1				
	previous	Activity		0..1				
	bcSurrogates	BiomedicalConceptSurrogate		0..*				
	bcCategories	BiomedicalConceptCategory		0..*				
Address			C25407		Address	A standardized representation of the location of a person, business, building, or organization. (NCI)		
	id	string						
	text	string	C201311		Address Full Text	A standardized representation of the complete set of components denoting the physical address of the person, business, building, or organization.		
	line	string	C25690		Address Line	The street name and number, building number, apartment or unit number, or post office box number where an entity is physically located.		
	district	string	C176229		District	An administrative or territorial division of a city, town, county, parish, state, country, or other locality based on a shared characteristic.		
	city	string	C25160		City	A relatively large and/or densely populated area of human habitation with administrative or legal status that may be specified as a component of a postal address.		
	postalCode	string	C25621		Postal Code	An alphanumeric code assigned to a mail delivery area.		
	state	string	C87194		State	A sub-division of a country that forms part of a federal union. States are usually, but not always, more autonomous than		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
						provinces and may have different laws from the central government.		
	country	Code	C25464	0..1	Country	A sovereign nation occupying a distinct territory and ruled by an autonomous government.	(Point out to ISO 3166-1 Alpha-3 Country code)	
AdministrationDuration			C69282		Administration Duration	The amount of time elapsed during the administration of an agent.		
	id	string						
	description	string	CNEW		Administration Duration Description	A narrative representation of the agent administration duration.		
	durationWillVary	Boolean	CNEW		Administration Duration Will Vary Indicator	An indication as to whether the agent administration duration is planned to vary within and/or across subjects.		
	reasonDurationWillVary	string	CNEW		Administration Duration Reason Duration Will Vary	The explanation for why the agent administration duration will vary within and/or across subjects.		
	quantity	Quantity	CNEW	1	Administration Duration Quantity Value	The value representing the amount of time elapsed during the administration of an agent.		
AgentAdministration			C70962		Agent Administration	The act of the dispensing, applying, or tendering a medical product or other agent.		
	id	string						
	name	string	CNEW		Agent Administration Name	The literal identifier (i.e., distinctive designation) of the agent administration.		
	description	string	CNEW		Agent Administration Description	A narrative representation of the agent administration.		
	label	string	CNEW		Agent Administration Label	The short descriptive designation for the agent administration.		
	duration	AdministrationDuration		1				
	route	Code	C38114	1	Route of Administration	The pathway by which a substance is administered in order to reach the site of action in the body.	SDTM Terminology Codelist C66729	
	dose	Quantity	CNEW	1	Agent Administration Dose	The value representing the amount of an agent given to an individual at one time.		
	frequency	Code	C89081	1	Dosing Frequency	The number of doses administered per a specific interval.	SDTM Terminology Codelist C71113	
AliasCode			C201344		Alias Code	An alternative symbol or combination of symbols which is assigned to the members of a collection.		
	id	string						
	standardCode	Code		1				
	standardCodeAliases	Code		0..*				
AnalysisPopulation			C188854		Target Study Population for Analysis	A target study population on which an analysis is performed. These may be represented by the entire study population, a subgroup defined by a particular characteristic measured at baseline, or a principal stratum defined by the occurrence (or non-occurrence, depending on context) of a specific intercurrent event. (ICH E9 R1 Addendum[5])		
	id	string						

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	text	string	CNEW		Analysis Population Text	An instance of unstructured text that represents the analysis population.		
	name	string	CNEW		Analysis Population Name	The literal identifier (i.e., distinctive designation) of the analysis population.		
	description	string	C188854		Target Study Population for Analysis Description	A narrative representation of the study population for analysis.		
	label	string	CNEW		Analysis Population Label	The short descriptive designation for the analysis population.		
BiomedicalConcept			C201345		Biomedical Concept	A unit of biomedical knowledge created from a unique combination of characteristics that include implementation details like variables and terminologies, used as building blocks for standardized, hierarchically structured clinical research information.		
	id	string						
	name	string	C201312		Biomedical Concept Name	The literal identifier (i.e., distinctive designation) of the biomedical concept.		
	label	string	CNEW		Biomedical Concept Label	The short descriptive designation for the biomedical concept.		
	synonyms	string	C201314		Biomedical Concept Synonym	A word or an expression that serves as a figurative, symbolic, or exact substitute for a biomedical concept, and which has the same meaning.		
	reference	string	C201313		Biomedical Concept Reference	A citation to an authoritative source for a biomedical concept.		
	code	AliasCode	CNEW	1	Biomedical Concept Concept Code	A concept unique identifier assigned to a biomedical concept that points to the meaning of that biomedical concept.		
	properties	BiomedicalConceptProperty		0..*				
BiomedicalConceptCategory			C201346		Biomedical Concept Category	A grouping of biomedical concepts based on some commonality or by user defined characteristics.		
	id	string						
	name	string	C201317		Biomedical Concept Category Name	The literal identifier (i.e., distinctive designation) of the biomedical concept category.		
	description	string	C201316		Biomedical Concept Category Description	A narrative representation of the biomedical concept category.		
	label	string	CNEW		Biomedical Concept Category Label	The short descriptive designation for the biomedical concept category.		
	code	AliasCode	C201315	0..1	Biomedical Concept Category Code	A symbol or combination of symbols which is assigned to the biomedical concept category.		
	members	BiomedicalConcept		0..*				
	children	BiomedicalConceptCategory		0..*				
BiomedicalConceptProperty			CNEW		Biomedical Concept Property	A characteristic from a set of characteristics used to define a biomedical concept.		
	id	string						
	name	string	CNEW		Biomedical Concept Property Name	The literal identifier (i.e., distinctive designation) of the biomedical concept property.		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	label	string	CNEW		Biomedical Concept Property Label	The short descriptive designation for the biomedical concept property.		
	isRequired	Boolean	CNEW		Biomedical Concept Property Required Indicator	An indication as to whether the biomedical concept property is required.		
	isEnabled	Boolean	CNEW		Biomedical Concept Property Enabled Indicator	An indication as to whether the biomedical concept property is activated for use within a given usage context for a biomedical concept.		
	datatype	string	C201319		Biomedical Concept Property Response Data Type	The structural format of the biomedical concept property response value. The datatype is carried in the attribute and influences the set of allowable values the attribute may assume. (After HL7)		
	code	AliasCode	C201318	1	Biomedical Concept Property Concept Code	A concept unique identifier assigned to a biomedical concept property that points to the meaning of that biomedical concept property.		
	responseCodes	ResponseCode		0..*				
BiomedicalConceptSurrogate								
	id	string						
	name	string	CNEW		Biomedical Concept Surrogate Name	The literal identifier (i.e., distinctive designation) of the biomedical concept surrogate.		
	description	string	C201320		Biomedical Concept Surrogate Description	A narrative representation of the biomedical concept surrogate.		
	label	string	CNEW		Biomedical Concept Surrogate Label	The short descriptive designation for the biomedical concept surrogate.		
	reference	string	C201321		Biomedical Concept Surrogate Reference	A citation to an authoritative source for a biomedical concept surrogate.		
Characteristic			C25447		Characteristic	The distinguishing qualities or prominent aspects of an entity.		
	id	string						SyntaxTemplate
	name	string	CNEW		Characteristic Name	The literal identifier (i.e., distinctive designation) of the characteristic.		SyntaxTemplate
	description	string	CNEW		Characteristic Description	A narrative representation of the characteristic.		SyntaxTemplate
	label	string	CNEW		Characteristic Label	The short descriptive designation for the characteristic.		SyntaxTemplate
	text	string	CNEW		Characteristic Text	An instance of structured text that represents the characteristic.		SyntaxTemplate
	dictionary	SyntaxTemplateDictionary		0..1				SyntaxTemplate
Code			C25162		Code	A symbol or combination of symbols which is assigned to the members of a collection.		
	id	string						
	code	string	C188858		Code Value	The literal value of a code.		
	codeSystem	string	C188859		Code System Name	The literal identifier (i.e., distinctive designation) of the system used to assign and/or manage codes.		
	codeSystemVersion	string	C188868		Code System Version	The version of the code system.		
	decode	string	C188861		Decode	Standardized or dictionary-derived human readable text associated with a code.		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
Condition			C25457		Condition	A state of being.		
	id	string						SyntaxTemplate
	name	string	CNEW		Condition Name	The literal identifier (i.e., distinctive designation) of the condition.		SyntaxTemplate
	description	string	CNEW		Condition Description	A narrative representation of the condition.		SyntaxTemplate
	label	string	CNEW		Condition Label	The short descriptive designation for the condition.		SyntaxTemplate
	text	string	CNEW		Condition Text	An instance of structured text that represents the condition.		SyntaxTemplate
	dictionary	SyntaxTemplateDictionary		0..1				SyntaxTemplate
	context	Activity, ScheduledActivityInstance		0..*				
	appliesTo	Activity, BiomedicalConcept, BiomedicalConceptCategory, BiomedicalConceptSurrogate, Procedure		0..*				
EligibilityCriterion			C16112		Study Eligibility Criteria	Characteristics which are necessary to allow a subject to participate in a clinical study, as outlined in the study protocol. The concept covers inclusion and exclusion criteria.		
	id	string						SyntaxTemplate
	name	string	CNEW		Study Eligibility Criteria Description	A narrative representation of the study eligibility criteria.		SyntaxTemplate
	description	string	CNEW		Study Eligibility Criteria Name	The literal identifier (i.e., distinctive designation) of the study eligibility criteria.		SyntaxTemplate
	label	string	CNEW		Study Eligibility Criteria Label	The short descriptive designation for the study eligibility criteria.		SyntaxTemplate
	text	string	CNEW		Eligibility Criteria Text	An instance of structured text that represents the study eligibility criteria.		SyntaxTemplate
	dictionary	SyntaxTemplateDictionary		0..1				SyntaxTemplate
	identifier	string	CNEW		Study Eligibility Criterion Identifier	A sequence of characters used to identify, name, or characterize the inclusion or exclusion criterion.		
	category	Code	C83016	1	Study Eligibility Criteria Category	A classification of the inclusion exclusion criterion.	SDTM Terminology Codelist C66797	
	context	StudyDesign, StudyVersion		0..1				
	next	EligibilityCriterion		0..1				
	previous	EligibilityCriterion		0..1				
Encounter			C142427		Clinical Encounter	Contact between subject/patient and healthcare practitioner/researcher, during which an assessment or activity is performed. Contact may be physical or virtual.		
	id	string						
	name	string	C171010		Clinical Encounter Name	The literal identifier (i.e., distinctive designation) for a protocol-defined clinical encounter.		
	description	string	C188836		Clinical Encounter Description	A narrative representation of the protocol-defined clinical encounter.		
	label	string	CNEW		Encounter Label	The short descriptive designation for the encounter.		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	environmentalSetting	Code	C188840	0..*	Environmental Setting	The environment/setting where the event, intervention, or finding occurred.	SDTM Terminology Codelist C127262	
	contactModes	Code	C188841	0..*	Contact Mode	The means by which an interaction occurs between the subject/participant and person or entity (e.g., a device).	SDTM Terminology Codelist C171445	
	type	Code	C188839	1	Clinical Encounter Type	A characterization or classification of contact between subject/patient and healthcare practitioner/researcher, during which an assessment or activity is performed.	C188728	
	transitionEndRule	TransitionRule		0..1				
	next	Encounter		0..1				
	transitionStartRule	TransitionRule		0..1				
	scheduledAt	Timing		0..1				
	previous	Encounter		0..1				
Endpoint			C25212		Study Endpoint	A defined variable intended to reflect an outcome of interest that is statistically analyzed to address a particular research question. NOTE: A precise definition of an endpoint typically specifies the type of assessments made, the timing of those assessments, the assessment tools used, and possibly other details, as applicable, such as how multiple assessments within an individual are to be combined. [After BEST Resource] (CDISC Glossary)		
	id	string						SyntaxTemplate
	name	string	CNEW		Endpoint Name	The literal identifier (i.e., distinctive designation) of the study endpoint.		SyntaxTemplate
	description	string	C188824		Study Endpoint Description	A narrative representation of the study endpoint.		SyntaxTemplate
	label	string	CNEW		Endpoint Label	The short descriptive designation for the study endpoint.		SyntaxTemplate
	text	string	CNEW		Study Endpoint Text	An instance of structured text that represents the study endpoint.		SyntaxTemplate
	dictionary	SyntaxTemplateDictionary		0..1				SyntaxTemplate
	purpose	string	C188825		Study Endpoint Purpose Description	The textual representation of the study endpoint purpose.		
	level	Code	C188826	1	Study Endpoint Level	A characterization or classification of the study endpoint that determines its category of importance relative to other study endpoints.	C188726	
Estimand			C188813		Estimand	A precise description of the treatment effect reflecting the clinical question posed by a given clinical trial objective. It summarises at a population level what the outcomes would be in the same patients under different treatment conditions being compared. (ICH E9 R1 Addendum)		
	id	string						

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	summaryMeasure	string	C188853		Population-Level Summary	A synopsis of the clinical endpoint of interest within the analysis target study population.		
	analysisPopulation	AnalysisPopulation		1				
	variableOfInterest	Endpoint		1				
	intercurrentEvents	IntercurrentEvent		1..*				
	intervention	StudyIntervention		1				
GeographicScope			CNEW		Geographic Scope	The extent or range related to the physical location of an entity.		
	id	string						
	code	AliasCode	CNEW	0..1	Geographic Scope Code	A symbol or combination of symbols which is assigned to the geographic scope.	(Point out to external dictionaries: Standard code is ISO-3166; Alias codes drawn from GENC, UN Region Codes, etc.)	
	type	Code	CNEW	1	Geographic Scope Type	A characterization or classification of the geographic scope.	CNEW - Geographic Scope Type Response	
GovernanceDate			CNEW		Study Governance Date	Any of the dates associated with event milestones within a clinical study's oversight and management framework.		
	id	string						
	name	string	CNEW		Study Governance Date Name	The literal identifier (i.e., distinctive designation) of the study governance date		
	description	string	CNEW		Study Governance Date Description	A narrative representation of the study governance date.		
	label	string	CNEW		Study Governance Date Label	The short descriptive designation for the study governance date.		
	dateValue	Date	CNEW		Study Governance Date Value	The information contained in the date field.		
	type	Code	CNEW	1	Protocol Approval Date Type	A characterization or classification of the protocol approval date.	CNEW - Governance Date Type Response	
	geographicScopes	GeographicScope		1..*				
Indication			C41184		Disease/Condition Indication	A health problem or disease that is identified as likely to be benefited by a therapy being studied in clinical trials.		
	id	string						
	name	string	CNEW		Disease Indication Name	The literal identifier (i.e., distinctive designation) of the disease indication.		
	description	string	C112038		Trial Disease/Condition Indication Description	A narrative representation of the condition, disease or disorder that the clinical trial is intended to investigate or address.		
	label	string	CNEW		Indication Label	The short descriptive designation for the indication.		
	isRareDisease	Boolean	CNEW		Disease Indication Is Rare Disease Indicator	An indication as to whether the disease indication under study is considered a rare disease.		
	codes	Code	C188822	0..*	Disease Indication Code	A short sequence of characters that represents the disease indication.	(Point out to multiple Biomedical coding dictionaries such as SNOMEDCT (for FDA), MedDRA, NCIt, ICD's, etc.)	

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
IntercurrentEvent			C188815		Intercurrent Event	An event(s) occurring after treatment initiation that affects either the interpretation or the existence of the measurements associated with the clinical question of interest. (ICH E9 Addendum on Estimands)		
	id	string						
	name	string	C188855		Intercurrent Event Name	The literal identifier (i.e., distinctive designation) of the intercurrent event.		
	description	string	C188856		Intercurrent Event Description	A narrative representation of the intercurrent event.		
	label	string	CNEW		Intercurrent Event Label	The short descriptive designation for the intercurrent event.		
	strategy	string	C188857		Intercurrent Event Strategy	A textual description of the planned strategy to manage and/or mitigate intercurrent events.		
Masking			C191278		Masking	The mechanism used to obscure the distinctive characteristics of the study intervention or procedure to make it indistinguishable from the comparator. NOTE: Blinding refers to study participants while masking refers to the study intervention. (CDISC Glossary)		
	id	string						
	description	string	CNEW		Masking Description	A narrative representation of the study masking strategy, based on a person's role within the study.		
	role	Code	CNEW	1	Masking Role	An identifying designation assigned to a masked individual within a study that corresponds with their function.	CNEW - Masking Role Response	
NarrativeContent			CNEW		Narrative Content	The container that holds an instance of unstructured text and which may include objects such as tables, figures, and images.		
	id	string						
	name	string	CNEW		Narrative Content Name	The literal identifier (i.e., distinctive designation) of the narrative content.		
	text	string	CNEW		Narrative Content Text	A textual representation of the narrative content.		
	sectionNumber	string	CNEW		Section Number	The numeric identifier assigned to a particular document section.		
	sectionTitle	string	CNEW		Section Title	An identifying designation for the document section.		
	children	NarrativeContent		0..*				
Objective			C142450		Study Objective	The reason for performing a study in terms of the scientific questions to be answered by the analysis of data collected during the study.		
	id	string						SyntaxTemplate
	name	string	CNEW		Study Objective Name	The literal identifier (i.e., distinctive designation) of the study objective.		SyntaxTemplate
	description	string	C94090		Study Objective Description	A narrative representation of the study objective. (BRIDG)		SyntaxTemplate

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	label	string	CNEW		Study Objective Label	The short descriptive designation for the study objective.		SyntaxTemplate
	text	string	CNEW		Study Objective Text	An instance of structured text that represents the study objective.		SyntaxTemplate
	dictionary	SyntaxTemplateDictionary		0..1				SyntaxTemplate
	level	Code	C188823	0..1	Study Objective Level	A characterization or classification of the study objective that determines its category of importance relative to other study objectives.	C188725	
	endpoints	Endpoint		0..*				
Organization			C19711		Organization	A formalized group of persons or other organizations collected together for a common purpose (such as administrative, legal, political) and the infrastructure to carry out that purpose. (BRIDG)		
	id	string						
	name	string	C93874		Organization Name	A non-unique textual identifier for the organization. (BRIDG)		
	label	string	CNEW		Organization Label	The short descriptive designation for the organization.		
	identifier	string	C93401		Organization Identifier	A unique symbol that establishes identity of the organization. (BRIDG)		
	identifierScheme	string	C188819		Identifier Provider Organization Name	The name of the organization that provides the identifier for the entity.		
	legalAddress	Address		0..1				
	organizationType	Code	C188820	1	Organization Type	A characterization or classification of the formalized group of persons or other organizations collected together for a common purpose (such as administrative, legal, political) and the infrastructure to carry out that purpose.	C188724	
PopulationDefinition			CNEW		Population Definition	A concise explanation of the meaning of a population.		
	id	string						
	name	string	CNEW		Population Definition Name	The literal identifier (i.e., distinctive designation) of the population definition.		
	description	string	CNEW		Population Definition Description	A narrative representation of the population definition.		
	label	string	CNEW		Population Definition Label	The short descriptive designation for the population definition.		
	includesHealthySubjects	Boolean	CNEW		Population Definition Includes Healthy Subjects Indicator	An indication as to whether the population definition includes healthy subjects, that is, subjects without the disease or condition under study.		
	plannedSex	Code	CNEW	1	Population Definition Planned Sex	The protocol-defined sex within the population definition.	SDTM Terminology Codelist C66732	
	criteria	EligibilityCriterion		1..*				
	plannedAge	Range	CNEW	0..1	Population Definition Planned Age	The anticipated age of subjects within the population definition.		
	plannedEnrollmentNumber	Range	CNEW	0..1	Population Definition Planned Enrollment Number	The value representing the planned number of subjects to be entered in a clinical trial, within the population definition.		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	plannedCompletionNumber	Range	CNEW	0..1	Population Definition Planned Completion Number	The value representing the planned number of subjects that must complete the study in order to meet the objectives and endpoints of the study, within the population definition.		
Procedure			C98769		Procedure	Any activity performed by manual and/or instrumental means for the purpose of diagnosis, assessment, therapy, prevention, or palliative care.		
	id	string						
	name	string	C201325		Procedure Name	The literal identifier (i.e., distinctive designation) of the procedure.		
	description	string	C201324		Procedure Description	A narrative representation of the procedure.		
	label	string	CNEW		Procedure Label	The short descriptive designation for the procedure.		
	procedureType	string	C188848		Procedure Type	A characterization or classification of the study procedure.		
	code	Code	C154626	1	Procedure Code	A symbol or combination of symbols which is assigned to medical procedure.	(Point out to external dictionary like CPT, MedDRA, SNOMEDCT, etc.)	
	studyIntervention	StudyIntervention		0..1				
Quantity			C25256		Quantity	How much there is of something that can be measured; the total amount or number.		
	id	string						
	value	Float	C25712		Quantity Value	A numerical quantity measured or assigned or computed.		
	unit	Code	C44258	0..1	Quantity Unit	The type of unit of measure being used to express a quantity.	SDTM Terminology Codelist C71620	
Range			C38013		Range	The difference between the lowest and highest numerical values; the limits or scale of variation.		
	id	string						
	minValue	Float	C25570		Minimum Value	The smallest value in quantity or degree in a set of values.		
	maxValue	Float	C25564		Maximum Value	The largest value in quantity or degree in a set of values.		
	isApproximate	Boolean	CNEW		Value Range is Approximate Indicator	An indication as to whether the value range is almost, but not quite, exact.		
	unit	Code	C25709	0..1	Unit of Measure	A named quantity in terms of which other quantities are measured or specified, used as a standard measurement of like kinds.	SDTM Terminology Codelist C71620	
ResearchOrganization			C93448		Research Organization	An organization that undertakes systematic investigation within a field of study in order to discover facts, establish or revise a theory, test a hypothesis, or develop a plan of action based on the facts discovered.		
	id	string						Organization
	name	string	CNEW		Research Organization Name	The literal identifier (i.e., distinctive designation) of the research organization.		Organization

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	label	string	CNEW		Research Organization Label	The short descriptive designation for the research organization.		Organization
	identifier	string	CNEW		Research Organization Identifier	A sequence of characters used to identify, name, or characterize the research organization.		Organization
	identifierScheme	string	CNEW		Identifier Provider Research Organization Name	The name of the research organization that provides the identifier for the entity.		Organization
	legalAddress	Address		0..1				Organization
	organizationType	Code	C188820	1	Organization Type	A characterization or classification of the formalized group of persons or other organizations collected together for a common purpose (such as administrative, legal, political) and the infrastructure to carry out that purpose.	C188724	Organization
	manages	StudySite		1..*				
ResponseCode			C201347		Response Code	A symbol or combination of symbols representing the response to the question.		
	id	string						
	isEnabled	Boolean	C201330		Response Code Enabled Indicator	An indication as to whether the response code is activated for use within a given usage context.		
	code	Code	C25162	1	Code	A symbol or combination of symbols which is assigned to the members of a collection.		
ScheduleTimeline			C201348		Schedule Timeline	A chronological schedule of planned temporal events.		
	id	string						
	name	string	C201334		Schedule Timeline Name	The literal identifier (i.e., distinctive designation) of the schedule timeline.		
	description	string	C201332		Schedule Timeline Description	A narrative representation of the schedule timeline.		
	label	string	CNEW		Schedule Timeline Label	The short descriptive designation for the schedule timeline.		
	entryCondition	string	C201333		Schedule Timeline Entry Condition	A logical evaluation on which rests the validity of entry into a schedule timeline.		
	mainTimeline	Boolean	C201331		Main Timeline Indicator	An indication as to whether the timeline or timeline component is part of the central or principal timeline.		
	instances	ScheduledInstance		0..*				
	entry	ScheduledInstance		1				
	exits	ScheduleTimelineExit		0..*				
	timings	Timing		0..*				
ScheduleTimelineExit			C201349		Schedule Timeline Exit	To go out of or leave the schedule timeline.		
	id	string						
ScheduledActivityInstance			C201350		Scheduled Activity Instance	A scheduled occurrence of an activity event.		
	id	string						ScheduledInstance
	defaultCondition	ScheduledInstance		0..1				ScheduledInstance
	epoch	StudyEpoch		0..1				ScheduledInstance
	timeline	ScheduleTimeline		0..1				ScheduledInstance
	timelineExit	ScheduleTimelineExit		0..1				ScheduledInstance

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	activities	Activity		0..*				
	encounter	Encounter		0..1				
ScheduledDecisionInstance			C201351		Scheduled Decision Instance	A scheduled occurrence of a decision event.		
	id	string						ScheduledInstance
	defaultCondition	ScheduledInstance		0..1				ScheduledInstance
	epoch	StudyEpoch		0..1				ScheduledInstance
	timeline	ScheduleTimeline		0..1				ScheduledInstance
	timelineExit	ScheduleTimelineExit		0..1				ScheduledInstance
	conditionAssignments	Map	C201335		Condition Assignments	An allotting or appointment to a set of conditions that are to be met in order to make a logical decision.		
ScheduledInstance			C201299		Scheduled Instance	A scheduled occurrence of a temporal event.		
	id	string						
	defaultCondition	ScheduledInstance		0..1				
	epoch	StudyEpoch		0..1				
	timeline	ScheduleTimeline		0..1				
	timelineExit	ScheduleTimelineExit		0..1				
Study			C15206		Clinical Study	A clinical study involves research using human volunteers (also called participants) that is intended to add to medical knowledge. There are two main types of clinical studies: clinical trials (also called interventional studies) and observational studies. [http://ClinicalTrials.gov](CDISC Glossary)		
	id	string						
	name	string	C68631		Study Name	The literal identifier (i.e., distinctive designation) of the study.		
	description	string	C142704		Study Description	A narrative representation of the study.		
	label	string	CNEW		Study Label	The short descriptive designation for the study.		
	versions	StudyVersion		0..*				
	documentedBy	StudyProtocolDocument		0..1				
StudyAmendment			CNEW		Study Amendment	A written description of a change(s) to, or formal clarification of, a study.		
	id	string						
	number	string	CNEW		Study Amendment Number	A string of numerals that uniquely identifies a protocol amendment.		
	summary	string	CNEW		Study Amendment Summary	A short narrative representation describing the changes introduced in the current version of the protocol.		
	substantialImpact	Boolean	CNEW		Study Amendment Substantial Impact Indicator	An indication as to whether the amendment likely to have a substantial impact on the safety or rights of the participants.		
	enrollments	SubjectEnrollment		1..*				
	secondaryReasons	StudyAmendmentReason		0..*				
	previous	StudyAmendment		0..1				
	primaryReason	StudyAmendmentReason		1				
StudyAmendmentReason			CNEW		Study Amendment Reason	The rationale for the change(s) to, or formal clarification of, a protocol.		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	id	string						
	otherReason	string	CNEW		Other Reason for Study Amendment	The rationale for the change(s) to, or formal clarification of, a protocol that is not otherwise specified.		
	code	Code	CNEW	1	Study Amendment Reason Code	A symbol or combination of symbols which is assigned to the study amendment reason.	CNEW - Study Amendment Reason Response	
StudyArm			C174447		Study Arm	A planned pathway assigned to the subject as they progress through the study, usually referred to by a name that reflects one or more treatments, exposures, and/or controls included in the path.		
	id	string						
	name	string	C170984		Study Arm Name	The literal identifier (i.e., distinctive designation) of the study arm.		
	description	string	C93728		Study Arm Description	A narrative representation of the study arm.		
	label	string	CNEW		Study Arm Label	The short descriptive designation for the study arm.		
	dataOriginDescription	string	C188828		Study Arm Data Origin Description	The textual representation of the study arm data origin.		
	dataOriginType	Code	C188829	1	Study Arm Data Origin Type	A characterization or classification of the study arm with respect to where the study arm data originates.	C188727	
	type	Code	C188827	1	Study Arm Type	A characterization or classification of the study arm.	Protocol Terminology Codelist C174222	
	populations	PopulationDefinition		0..*				
StudyCell			C188810		Study Design Cell	A partitioning of a study arm into individual pieces, which are associated with an epoch and any number of sequential elements within that epoch.		
	id	string						
	arm	StudyArm		1				
	epoch	StudyEpoch		1				
	elements	StudyElement		0..*				
StudyCohort			C61512		Study Cohort	A group of individuals who share a set of characteristics (e.g., exposures, experiences, attributes), which logically defines a population under study.		
	id	string						PopulationDefinition
	name	string	CNEW		Study Cohort Name	The literal identifier (i.e., distinctive designation) of the study cohort.		PopulationDefinition
	description	string	CNEW		Study Cohort Description	A narrative representation of the study cohort.		PopulationDefinition
	label	string	CNEW		Study Cohort Label	The short descriptive designation for the study cohort.		PopulationDefinition
	includesHealthySubjects	Boolean	CNEW		Study Cohort Includes Healthy Subjects Indicator	An indication as to whether the study cohort includes healthy subjects, that is, subjects without the disease or condition under study.		PopulationDefinition
	plannedSex	Code	CNEW	1	Planned Sex of Study Cohort Participants	The protocol-defined sex of the study cohort.	SDTM Terminology Codelist C66732	PopulationDefinition
	criteria	EligibilityCriterion		1..*				PopulationDefinition

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	plannedAge	Range	CNEW	0..1	Study Cohort Planned Age	The protocol-defined age of subjects within the study cohort.		PopulationDefinition
	plannedEnrollmentNumber	Range	C49692	0..1	Planned Number of Participants in Study Cohort	The protocol-defined number of subjects within a study cohort.		PopulationDefinition
	plannedCompletionNumber	Range	CNEW	0..1	Study Cohort Planned Completion Number	The value representing the planned number of subjects that must complete the study in order to meet the objectives and endpoints of the study, within the study cohort.		PopulationDefinition
	characteristics	Characteristic		0..*				
StudyDesign			C15320		Study Design	A plan detailing how a study will be performed in order to represent the phenomenon under examination, to answer the research questions that have been asked, and informing the statistical approach.		
	id	string						
	name	string	C201338		Study Design Name	The literal identifier (i.e., distinctive designation) of the study design.		
	description	string	C147139		Study Design Description	A narrative representation of the study design.		
	label	string	CNEW		Study Design Label	The short descriptive designation for the study design.		
	rationale	string	C142705		Study Design Rationale	Reason(s) for choosing the study design. This may include reasons for the choice of control or comparator, as well as the scientific rationale for the study design.		
	activities	Activity		0..*				
	trialIntentTypes	Code	C49652	0..*	Trial Intent Type	The planned purpose of the therapy, device, or agent under study in the clinical trial.	SDTM Terminology Codelist C66736	
	blindingSchema	Code	C49658	0..1	Trial Blinding Schema	The type of experimental design used to describe the level of awareness of the study subjects and/ or study personnel as it relates to the respective intervention(s) or assessments being observed, received or administered.	SDTM Terminology Codelist C66735	
	therapeuticAreas	Code	C101302	0..*	Therapeutic Areas	A categorization of a disease, disorder, or other condition based on common characteristics and often associated with a medical specialty focusing on research and development of specific therapeutic interventions for the purpose of treatment and prevention.	(Point out to external dictionaries)	
	characteristics	Code	CNEW	0..*	Study Design Characteristic	The distinguishing qualities or prominent aspect of a study design.	CNEW - Study Design Characteristics Response	
	trialTypes	Code	C49660	0..*	Trial Type	The nature of the interventional study for which information is being collected.	SDTM Terminology Codelist C66739	
	interventionModel	Code	C98746	1	Intervention Model Type	The general design of the strategy for assigning interventions to participants in a clinical study. (clinicaltrials.gov)	SDTM Terminology Codelist C99076	
	encounters	Encounter		0..*				
	estimands	Estimand		0..*				

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	indications	Indication		0..*				
	maskingRoles	Masking		0..*				
	objectives	Objective		0..*				
	organizations	ResearchOrganization		0..*				
	scheduleTimelines	ScheduleTimeline		0..*				
	arms	StudyArm		1..*				
	studyCells	StudyCell		1..*				
	elements	StudyElement		0..*				
	documentVersion	StudyProtocolDocumentVersion		0..1				
	studyInterventions	StudyIntervention		0..*				
	epochs	StudyEpoch		1..*				
	population	StudyDesignPopulation		0..1				
StudyDesignPopulation			C142728		Target Study Population	The population within the general population to which the study results can be generalized.		
	id	string						PopulationDefinition
	name	string	CNEW		Target Study Population Name	The literal identifier (i.e., distinctive designation) of the target study population.		PopulationDefinition
	description	string	C70834		Target Study Population Description	A narrative representation of the study population.		PopulationDefinition
	label	string	CNEW		Study Design Population Label	The short descriptive designation for the study design population.		PopulationDefinition
	includesHealthySubjects	Boolean	CNEW		Study Population Includes Healthy Subjects Indicator	An indication as to whether the population definition includes healthy subjects, that is, subjects without the disease or condition under study.		PopulationDefinition
	plannedSex	Code	C49696	1	Sex of Participants	The specific sex, either male, female, or mixed of the subject group being studied. (NCI)	SDTM Terminology Codelist C66732	PopulationDefinition
	criteria	EligibilityCriterion		1..*				PopulationDefinition
	plannedAge	Range	CNEW	0..1	Study Design Population Planned Age	The protocol-defined age of subjects within the study design population.		PopulationDefinition
	plannedEnrollmentNumber	Range	CNEW	0..1	Study Design Population Planned Enrollment Number	The value representing the planned number of subjects to be entered in a clinical trial, within the study design population.		PopulationDefinition
	plannedCompletionNumber	Range	CNEW	0..1	Study Design Population Planned Completion Number	The value representing the planned number of subjects that must complete the study in order to meet the objectives and endpoints of the study, within the study design population.		PopulationDefinition
	cohorts	StudyCohort		0..*				
StudyElement			C142735		Study Design Element	A basic building block for time within a clinical study comprising the following characteristics: a description of what happens to the subject during the element; a definition of the start of the element; a rule for ending the element.		
	id	string						
	name	string	C188833		Study Design Element Name	The literal identifier (i.e., distinctive designation) of the study design element.		
	description	string	C188834		Study Design Element Description	A narrative representation of the study design element.		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	label	string	CNEW		Study Element Label	The short descriptive designation for the study element.		
	transitionEndRule	TransitionRule		0..1				
	studyInterventions	StudyIntervention		0..*				
	transitionStartRule	TransitionRule		0..1				
StudyEpoch			C71738		Study Epoch	A named time period defined in the protocol, wherein a study activity is specified and unchanging throughout the interval, to support a study-specific purpose.		
	id	string						
	name	string	C93825		Study Epoch Name	The literal identifier (i.e., distinctive designation) of the study epoch, i.e., the named time period defined in the protocol, wherein a study activity is specified and unchanging throughout the interval, to support a study-specific purpose.		
	description	string	C93824		Study Epoch Description	A narrative representation of the study epoch.		
	label	string	CNEW		Study Epoch Label	The short descriptive designation for the study epoch.		
	type	Code	C188830	1	Study Epoch Type	A characterization or classification of the study epoch, i.e., the named time period defined in the protocol, wherein a study activity is specified and unchanging throughout the interval, to support a study-specific purpose.	SDTM Terminology Codelist C99079	
	previous	StudyEpoch		0..1				
	next	StudyEpoch		0..1				
StudyIdentifier			C83082		Study Identifier	A sequence of characters used to identify, name, or characterize the study.		
	id	string						
	studyIdentifier	string	C83082		Study Identifier	A sequence of characters used to identify, name, or characterize the study.		
	studyIdentifierScope	Organization		1				
StudyIntervention			CNEW		Study Intervention	Any agent, device, or procedure being tested or used as a reference or comparator in the conduct of a clinical trial.		
	id	string						
	description	string	CNEW		Study Intervention Description	A narrative representation of the study intervention.		
	name	string	CNEW		Study Intervention Name	The literal identifier (i.e., distinctive designation) of the study intervention.		
	label	string	CNEW		Study Intervention Label	The short descriptive designation for the study intervention.		
	administrations	AgentAdministration		1..*				
	type	Code	C98747	1	Study Intervention Type	The kind of product or procedure studied in a trial.	SDTM Terminology Codelist C99078	
	role	Code	CNEW	1	Study Intervention Role	The intended use of the trial intervention within the context of the study design.	CNEW - Study Intervention Role Response	
	productDesignation	Code	CNEW	1	Study Intervention Product Designation	An indication as to whether the investigational intervention is an	CNEW - Study Intervention Product Designation Response	

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
						investigational medicinal product or an auxiliary medicinal product.		
	pharmacologicClass	Code	C98768	0..1	Pharmacologic Class	The pharmacological class of the investigational product.	(Points to external codelists; FDA requirement to use…)	
	codes	Code	CNEW	0..*	Study Intervention Code	A symbol or combination of symbols which is assigned to the study intervention.	(Point out to multiple Biomedical coding dictionaries such as WHODrug, ATC, UNII, etc.)	
	minimumResponseDuration	Quantity	CNEW	0..1	Study Intervention Minimum Response Duration	The value representing the minimum amount of time required to meet the criteria for response to study intervention.		
StudyProtocolDocument			C93381		Study Protocol Document	A representation of the study protocol (that persists over time) in document form.		
	id	string						
	name	string	CNEW		Study Protocol Document Name	The literal identifier (i.e., distinctive designation) of the study protocol document.		
	description	string	CNEW		Study Protocol Document Description	A narrative representation of the study protocol document.		
	label	string	CNEW		Study Protocol Document Label	The short descriptive designation for the study protocol document.		
	versions	StudyProtocolDocumentVersion		0..*				
StudyProtocolDocumentVersion			C93490		Study Protocol Version	A plan at a particular point in time for a formal investigation to assess the utility, impact, pharmacological, physiological, and/or psychological effects of a particular treatment, procedure, drug, device, biologic, food product, cosmetic, care plan, or subject characteristic. (BRIDG)		
	id	string						
	protocolVersion	string	C93490		Study Protocol Version	A plan at a particular point in time for a formal investigation to assess the utility, impact, pharmacological, physiological, and/or psychological effects of a particular treatment, procedure, drug, device, biologic, food product, cosmetic, care plan, or subject characteristic. (BRIDG)		
	protocolStatus	Code	C188818	1	Protocol Status	A condition of the protocol at a point in time with respect to its state of readiness for implementation.	C188723	
	dateValues	GovernanceDate		0..*				
	contents	NarrativeContent		0..*				
	children	StudyProtocolDocumentVersion		0..*				
StudySite			C80403		Study Site	The location at which a study investigator conducts study activities.		
	id	string						
	name	string	CNEW		Study Site Name	The literal identifier (i.e., distinctive designation) of the study site.		
	description	string	CNEW		Study Site Description	A narrative representation of the study site.		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	label	string	CNEW		Study Site Label	The short descriptive designation for the study site.		
	currentEnrollment	SubjectEnrollment		0..1				
StudyTitle			C49802		Study Title	The sponsor-defined name of the clinical study.		
	id	string						
	text	string	CNEW		Study Title Text	An instance of unstructured text that represents the study title.		
	type	Code	CNEW	1	Study Title Type	A characterization or classification of the study title.	CNEW-Study Title Type Response	
StudyVersion			C188816		Study Version	A plan at a particular point in time for a study.		
	id	string						
	versionIdentifier	string	CNEW		Study Version Identifier	A sequence of characters used to identify, name, or characterize the study version.		
	rationale	string	C94122		Study Rationale	A statement describing the overall rationale of the study. This field describes the contribution of this study to product development (i.e., what knowledge is being contributed from the conduct of this study).		
	studyPhase	AliasCode	C48281	0..1	Trial Phase	A step in the clinical research and development of a therapy from initial clinical trials to post-approval studies. NOTE: Clinical trials are generally categorized into 4 (sometimes 5) phases. A therapeutic intervention may be evaluated in 2 or more phases simultaneously in different trials, and some trials may overlap 2 different phases.(NCI)	SDTM Terminology Codelist C66737	
	businessTherapeuticAreas	Code	CNEW	0..*	Business Therapeutic Areas	A therapeutic area classification based on the structure and operations of the business unit.	(Point out to external dictionaries)	
	studyType	Code	C142175	0..1	Study Type Classification	The nature of the investigation for which study information is being collected. (ClinicalTrials.gov)	SDTM Terminology Codelist C99077	
	dateValues	GovernanceDate		0..*				
	amendments	StudyAmendment		0..*				
	studyDesigns	StudyDesign		0..*				
	studyIdentifiers	StudyIdentifier		0..*				
	documentVersion	StudyProtocolDocumentVersion		0..1				
	titles	StudyTitle		1..*				
SubjectEnrollment			C37948		Subject Enrollment	The act of enrolling subjects into a study. The subject will have met the inclusion/exclusion criteria to participate in the trial and will have signed an informed consent form. (CDISC Glossary)		
	id	string						GeographicScope
	code	AliasCode	CNEW	0..1	Subject Enrollment Code	A symbol or combination of symbols which is assigned to the subject enrollment.		GeographicScope

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	type	Code	CNEW	1	Subject Enrollment Type	A characterization or classification of the subject enrollment.		GeographicScope
	quantity	Quantity	CNEW	1	Subject Enrollment Quantity Value	The value representing the number of individuals enrolled in a study.		
SyntaxTemplate			CNEW		Syntax Template	A standardized pattern used for the arrangement of words and phrases to create well-formed, structured sentences.		
	id	string						
	name	string	CNEW		Syntax Template Name	The literal identifier (i.e., distinctive designation) of the syntax template.		
	description	string	CNEW		Syntax Template Description	A narrative representation of the syntax template.		
	label	string	CNEW		Syntax Template Label	The short descriptive designation for the syntax template.		
	text	string	CNEW		Syntax Template Text	A structured text string containing prescribed text interspersed with user-defined parameter values.		
	dictionary	SyntaxTemplateDictionary		0..1				
SyntaxTemplateDictionary			CNEW		Syntax Template Dictionary	A reference source that provides a listing of valid parameter names and values used in syntax template text strings.		
	id	string						
	name	string	CNEW		Syntax Template Dictionary Name	The literal identifier (i.e., distinctive designation) of the syntax template dictionary.		
	description	string	CNEW		Syntax Template Dictionary Description	A narrative representation of the syntax template dictionary.		
	label	string	CNEW		Syntax Template Dictionary Label	The short descriptive designation for the syntax template dictionary.		
	parameterMap	Map	CNEW		Syntax Template Dictionary Parameter Map	The paired name and value contained within the syntax template dictionary for a given parameter.		
Timing			C80484		Timing	The chronological relationship between temporal events.		
	id	string						
	name	string	CNEW		Timing Name	The literal identifier (i.e., distinctive designation) of the timing.		
	description	string	C164648		Timing Description	The textual representation of the chronological relationship between temporal events.		
	label	string	CNEW		Timing Label	The short descriptive designation for the timing.		
	value	string	C201341		Timing Value	The temporal value of the chronological relationship between temporal events.		
	window	string	C48921		Timing Window	A time period, or other type of interval, during which a temporal event may be achieved, obtained, or observed.		
	windowLower	string	C201342		Timing Window, Lower	The earliest chronological value of an allowable period of time during which a temporal event takes place.		
	windowUpper	string	C201343		Timing Window, Upper	The latest chronological value of an allowable period of time during which a temporal event takes place.		

Class Name	Attribute Name	Data Type	NCI C-Code	Cardinality	Preferred Term	Definition	Codelist Ref	Inherited From
	relativeToFrom	Code	C201297	1	Timing Relative To From	The name of the reference event used to define the temporal relationship with another event.	C201265	
	type	Code	C201298	1	Timing Type	A characterization or classification of the chronological relationship between temporal events.	C201264	
	relativeToScheduledInstance	ScheduledInstance		0..1				
	relativeFromScheduledInstance	ScheduledInstance		0..1				
TransitionRule			C82567		Transition Rule	A guide that governs the allocation of subjects to operational options at a discrete decision point or branch (e.g., assignment to a particular arm, discontinuation) within a clinical trial plan.		
	id	string						
	name	string	CNEW		Transition Rule Name	The literal identifier (i.e., distinctive designation) of the transition rule.		
	description	string	C188835		Transition Rule Description	A narrative representation of the transition rule.		
	label	string	CNEW		Transition Rule Label	The short descriptive designation for the transition rule.		
	text	string	CNEW		Transition Rule Text	An instance of unstructured text that represents the transition rule.		

6 USDM API

The reference architecture API is designed as a mechanism for bulk transfer to allow for the creation of a study within the SDR, the reading of such a study, and the update of a study. No other API features are defined, nor is a granular API defined at this time.

The API has been defined using the OpenApi Specification. The various routes, rules, and constraints for the use of the API are contained within the API specification itself. If further routes, rules, and constraints are required, these will be added to the machine-readable specification.

When expressing USDM data in a monolithic, hierarchical document format (e.g., JSON, XML), the same element will appear multiple times because the model uses only class references for USDM entities. This is not optimal for an API and, so as not to repeat the same information within the JSON structure, the API has been designed to include an instance once and only once and allow for zero, 1, or more references to it as dictated by the USDM and the relationships therein. This mechanism relies on the unique identifiers of each class.

To ensure no duplication of content in the API JSON format, the following series of steps are taken to translate the logical USDM into the JOSN format:

1. Where content is shared (referenced from 2 or more places), the "natural parent" relationship is identified. An example is the Endpoint class that is referenced from both the Objective and Estimand classes. Objective is considered the natural parent.
2. If a natural parent can be identified in the API, then the content of the child is included in the corresponding item of the natural parent (attribute names remain unchanged) and other relationships are added as cross-references, with the attribute names modified with a suffix of "Id" (singular) or "Ids" (plural) relationships. The datatype is modified to string so as to accommodate the cross-references and the corresponding identifiers.
3. If the natural parent cannot be identified then a "collection" from a logical higher level class is formed and all relationships to this class in the logical model are added as cross-references in the API with the corresponding naming modifications as specified in step 2. This results in an additional relationship in the API for the higher level class to the collection. An example is for the class BiomedicalConcepts where a collection is placed within the StudyDesign class.

One other feature found within the API is the addition of the instanceType attribute. This attribute is added to state the class name. This InstanceType attribute is an API-only artifact and, as such, does not get included in the UML diagram or within the CT.

7 Mapping to Other Standards and Formats

7.1 Creation of SDTM Trial Design Domains

Alignment between the USDM and SDTM Trial Design domains and controlled terminology elements related to study design enables the (automated) creation of the SDTM Trial Design Domains. The SDTM Implementation Guide (SDTMIG) includes a section related to Trial Design datasets. The corresponding trial design concepts include:

- Trial design
- Epoch
- Arm
- Study cell
- Element
- Branch
- Treatments
- Visit
- Criteria

These concepts are used for the following Trial Design Domains:

- Trial Arms (TA)
- Trial Elements (TE)
- Trial Visits (TV)
- Trial Inclusion/Exclusion Criteria (TI)
- Trial Summary (TS)

Other trials design domains like Trial Disease Assessments (TD) and Trial Disease Milestones (TM) that are described in the SDTMIG contain information that is stored in the USDM as well; these, however, are not explicitly discussed in this section.

The USDM structure that informs the TA, TE, and TV domains is described in Section 4.10, Arms and Epochs.

The following table provides an overview of the mapping of USDM to the **SDTM TA domain**.

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
STUDYID	Study Identifier	Char	Identifier	Req	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier		study.studyVersion.studyIdentifier.organization. type.code=C188724 (Clinical StudySponsor)

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
DOMAIN	Domain Abbreviation	Char	Identifier	Req			Set to "TA"
ARMCD	Planned Arm Code	Char	Topic	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm/@name		
ARM	Description of Planned Arm	Char	Synonym Qualifier	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm/@description		
TAETORD	Planned Order of Element within Arm	Num	Timing	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@epoch /StudyEpoch/@previous | @next	..../StudyCell/@arm ..../StudyCell/@elements	Link epochs via StudyCell to the corresponding study elements. Order epochs and their related elements based on previous StudyEpoch and next StudyEpoch attributes and derive a corresponding ordering number.
ETCD	Element Code	Char	Record Qualifier	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@elements /StudyElement/@name	..../StudyCell/@arm	
ELEMENT	Description of Element	Char	Synonym Qualifier	Perm	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@elements /StudyElement/@description	..../StudyCell/@arm	
TABRANCH	Branch	Char	Rule	Exp	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@scheduleTimelines /ScheduleTimeline/@instances /ScheduledDecisionInstance/@conditionAssignments	..../StudyCell/@epoch ..../StudyCell/@arm	ScheduledInstances in a timeline point to a StudyEpoch (see Section 4.14, Study Timing). Branching information can be stored as scheduledDecisionInstances using the ConditionAssignment that points to the first instance related to the next epoch.
TATRANS	Transition Rule	Char	Rule	Exp	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@scheduleTimelines /ScheduleTimeline/@instances /ScheduledDecisionInstance/@conditionAssignments	..../ScheduledActivityInstance/@epoch .../StudyCell/@epoch ..../StudyCell/@arm	ScheduledInstances in a timeline point to a StudyEpoch (see Section 4.14, Study Timing). Transition rule information is stored as scheduledDecisionInstances using the ConditionAssignment that points to an instance not being the default next instance on the timeline.
EPOCH	Epoch	Char	Timing	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@epoch /StudyEpoch/@name	..../StudyCell/@arm	

The following table provides an overview of the mapping of USDM to the **SDTM TE domain**.

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
STUDYID	Study Identifier	Char	Identifier	Req	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier		study.studyVersion.studyIdentifier.organization. type.code=C188724 (Clinical StudySponsor)
DOMAIN	Domain Abbreviation	Char	Identifier	Req			Set to "TE"

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
ETCD	Element Code	Char	Topic	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@elements /StudyElement/@name		
ELEMENT	Description of Element	Char	Synonym Qualifier	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@elements /StudyElement/@description		
TESTRL	Rule for Start of Element	Char	Rule	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@elements /StudyElement/@transitionStartRule /TransitionRule/@text		
TEENRL	Rule for End of Element	Char	Rule	Perm	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@elements /StudyElement/@transitionEndRule /TransitionRule/@text		
TEDUR	Planned Duration of Element	Char	Timing	Perm	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@scheduleTimelines /ScheduleTimeline/@instances /ScheduledActivityInstance/@timings /Timing/@value	..../ScheduledActivityInstance/@epoch ..../StudyCell/@epoch ..../StudyCell/@elements	Select scheduleInstances that relate to start of the associated StudyEpoch associated with the corresponding study Element via StudyCell. Select the scheduleInstance associated with the start of the next studyEpoch. Use Timing.values of all related timings that specify the period in between for calculation of the total element duration.

The following table provides an overview of the mapping of USDM to the **SDTM TV domain**.

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
STUDYID	Study Identifier	Char	Identifier	Req	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier		study.studyVersion.studyIdentifier.organization. type.code=C188724 (Clinical StudySponsor)
DOMAIN	Domain Abbreviation	Char	Identifier	Req			Set to "TV"
VISITNUM	Visit Number	Num	Topic	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@encounter /Encounter/@previous | @next		Order encounters based previous and next attributes and derive the visit order number correspondingly. Assign numbers based on applicable standard visit numbering rules.
VISIT	Visit Name	Char	Synonym Qualifier	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@encounter /Encounter/@name		
VISITDY	Planned Study Day of Visit	Num	Timing	Perm	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@encounter /Encounter/@timing /Timing/@timingValue		

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
ARMCD	Planned Arm Code	Char	Record Qualifier	Exp	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@arm /StudyArm/@name	..../StudyCell/@epoch ..../ScheduledActivityInstance/@epoch ..../ScheduledActivityInstance/@encounter	In case visits differ by arm, the corresponding arm can be derived via the ScheduledActivityInstance relating the encounter via StudyEpoch and StudyCell to the corresponding StudyArm.
ARM	Description of Planned Arm	Char	Synonym Qualifier	Perm	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@arm /StudyArm/@description	..../StudyCell/@epoch ..../ScheduledActivityInstance/@epoch ..../ScheduledActivityInstance/@encounter	
TVSTRL	Visit Start Rule	Char	Rule	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@encounter /Encounter/@transitionStartRule /TransitionRule/@text		
TVENRL	Visit End Rule	Char	Rule	Perm	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@encounter /Encounter/@transitionEndRule /TransitionRule/@text		

The following table provides an overview of the mapping of USDM to the **SDTM TI domain**.

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
STUDYID	Study Identifier	Char	Identifier	Req	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier		study.studyVersion.studyIdentifier.organization. type.code=C188724 (Clinical StudySponsor)
DOMAIN	Domain Abbreviation	Char	Identifier	Req			Set to "TI"
IETESTCD	Incl/Excl Criterion Short Name	Char	Topic	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation|StudyCohort/@criteria /EligibilityCriteria/@identifier		Eligibility criteria might be directly linked to a study Population or via one of the corresponding cohorts. Therefore an alternative path is specified via the StudyCohort class.
IETEST	Inclusion/Exclusion Criterion	Char	Synonym Qualifier	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation|StudyCohort/@criteria /EligibilityCriteria/@text		The eligibility criteria are based on the SyntaxTemplate class (see Section 4.21). Referenced values need to be replaced by actual values before creation of IETEST.
IECAT	Inclusion/Exclusion Category	Char	Grouping Qualifier	Req	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation|StudyCohort/@criteria /EligibilityCriteria/@category /code/@decode		
IESCAT	Inclusion/Exclusion Subcategory	Char	Grouping Qualifier	Perm			Permitted value. Not available in USDM. Can be applied according to user preference.

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
TIRL	Inclusion/Exclusion Criterion Rule	Char	Rule	Perm	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation|StudyCohort/@criteria /EligibilityCriteria/@text		The eligibility criteria are based on the SyntaxTemplate class (see Section 4.21), which enhances computer readability. References values should **not** be replaced by actual values for TIRL.
TIVERS	Protocol Criteria Versions	Char	Record Qualifier	Perm	Study/@versions /StudyVersion/@documentVersion /StudyProtocolDocumentVersion/@protocolVersion		

The following table provides an overview of the mapping of USDM to the **SDTM TS domain**.

Variable Name	Variable Label	Type	Role	Core	USDM Path and Attribute	Required USDM relationships	Selection / Derivation
STUDYID	Study Identifier	Char	Identifier	Req	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier		study.studyVersion.studyIdentifier.organization. type.code=C188724 (Clinical StudySponsor)
DOMAIN	Domain Abbreviation	Char	Identifier	Req			Set to "TS"
TSSEQ	Sequence Number	Num	Identifier	Req	*See TSPARM mapping table below*		
TSGRPID	Group ID	Char	Identifier	Perm	*See TSPARM mapping table below*		
TSPARMCD	Trial Summary Parameter Short Name	Char	Topic	Req	*See TSPARM mapping table below*		
TSPARM	Trial Summary Parameter	Char	Synonym Qualifier	Req	*See TSPARM mapping table below*		
TSVAL	Parameter Value	Char	Result Qualifier	Exp	*See TSPARM mapping table below.If not otherwise specified:*...Code/@decode		
TSVALNF	Parameter Value Null Flavor	Char	Result Qualifier	Perm	*Fill in case of missing values with expected data as described in the SDTMIG*		
TSVALCD	Parameter Value Code	Char	Result Qualifier	Exp	*See TSPARM mapping table below.If not otherwise specified:*...Code/@decode		
TSVCDREF	Name of Reference Terminology	Char	Result Qualifier	Exp	*See TSPARM mapping table below.* *If not otherwise specified:*...Code/@codeSystem		
TSVCDVER	Version of the Reference Terminology	Char	Result Qualifier	Exp	*See TSPARM mapping table below.* *If not otherwise specified:*...Code/@codeSystemVersion		

The following table provides a list of published Trial Summary parameters (TSPARM) and their mapping to USDM elements (i.e., entities, attributes, valid values). The table includes only those parameters for which there is a mapping. Frequently used and required parameters are included.

The table is based on the SDTM Controlled Terminology codelist C66738, from SDTM Terminology Version 2023-09-29. For all synonyms and definitions, please see the corresponding terminology file.

TSPARM	TSPARMCD	Code	Codelist Code	TSVAL USDM Path and Attribute	Selection / Derivations	TSSEQ	TSGRPID
Adaptive Design	ADAPT	C146995	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@characteristics /code/@decode	If characteristics include "ADAPTIVE" then TSVAL="Y" and TSVALCD="C49488" Otherwise TSVAL="N" and TSVALCD="C49487"		
Planned Minimum Age of Subjects	AGEMIN	C49693	C66738	Study/@versions /StudyVersion/@studyDesigns	Use minimum of minimum age values of all populations included (studyDesignPopulations and Cohorts). Transform according to ISO 8601		

TSPARM	TSPARMCD	Code	Codelist Code	TSVAL USDM Path and Attribute	Selection / Derivations	TSSEQ	TSGRPID
				/StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation |StudyCohort/@plannedAge /Range/@minValue + @unit	standards. If one ore more populations have a null minValue then TSVAL should be set to null and TSVALNF should be filled instead according to ISO 21090.		
Planned Minimum Age of Subjects	AGEMAX	C49694	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation |StudyCohort/@plannedAge /Range/@maxValue + @unit	Use maximum of maximum age values of all populations included (studyDesignPopulations and Cohorts). Transform according to ISO 8601 standards. If one ore more populations have a null maxValue then TSVAL should be set to null and TSVALNF should be filled instead according to ISO 21090.		
Comparative Treatment Name	COMPTRT	C68612	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@name	..StudyIntervention/@role/ Code/@Code<>"C41161" (not "Experimental Intervention") and ..StudyIntervention/@productDesignation/ Code/@decode="IMP"	Add Unique number if more than 1	If applicable, combine with the corresponding intervention variables by a common tsgrpid
Current Therapy or Treatment	CURTRT	C85582	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@name	..StudyIntervention/@role/ Code/@Code="C165822" ("Background Treatment")	Add Unique number if more than 1	If applicable, combine with the corresponding intervention variables by a common tsgrpid
Dose Level; Dose per Administration	DOSE	C25488	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@administrations /AgentAdministration/@dose /Quantity/@value			If applicable, combine with the corresponding intervention variables by a common tsgrpid
Dosing Frequency	DOSFRQ	C89081	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@administrations /AgentAdministration/@frequency			If applicable, combine with the corresponding intervention variables by a common tsgrpid
Dose Units	DOSU	C73558	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@administrations /AgentAdministration/@dose /Quantity/@unit			If applicable, combine with the corresponding intervention variables by a common tsgrpid
Extension Trial Indicator	EXTTIND	C139274	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@characteristics /code/@decode	If characteristics include "Extension" then TSVAL="Y" and TSVALCD="C49488" Otherwise TSVAL="N" and TSVALCD="C49487"		
Planned Country of Investigational Sites	FCNTRY	C98770	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@appliesTo /StudySite/@currentEnrollment /SubjectEnrollment/@code /AliasCode/@StandardCode	SubjectEnrollment/@type /code/@code=C25464 ("Country")	Add Unique number if more than 1	
Healthy Subject Indicator	HLTSUBJI	C98737	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population	If True then TSVAL="Y" and TSVALCD="C49488" If False then TSVAL="N" and TSVALCD="C49487"		

TSPARM	TSPARMCD	Code	Codelist Code	TSVAL USDM Path and Attribute	Selection / Derivations	TSSEQ	TSGRPID
				(/StudyDesignPopulation/@cohorts) /StudyDesignPopulation |StudyCohort/@includesHealthySubjects			
Trial Disease/Condition Indication; Trial Disease/Condition Indication Description	INDIC	C112038	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@indications /Indication/@name or @description			
Intervention Model	INTMODEL	C98746	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@interventionModel			
Intervention Type	INTTYPE	C98747	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@type			If applicable, combine with the corresponding intervention variables by a common tsgrpid
Trial Length	LENGTH	C49697	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@scheduleTimelines /ScheduleTimeline/@instances /ScheduledActivityInstance/@timings /Timing/@value	Select scheduleInstances that relate to start of the study. Select the scheduleInstance associated with the end of the study. Use Timing.values of all related timings that specify the period in between for calculation of the total trial length.		
Planned Number of Arms	NARMS	C98771	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm	Count number of instances (each instance is an arm) defined in StudyArm class		
Number of Groups/Cohorts	NCOHORT	C126063	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/@cohorts /StudyCohort	Count number of instances (each instance is an cohort) defined in StudyCohort class		
Trial Exploratory Objective	OBJEXP	C163559	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@text	Objective/@level /code/@Code = C163559 ("Exploratory Objective") Objectives are based on the SyntaxTemplate class (see Section 4.20). References values need to be replaced by actual values before creation of OBJEXP.	Add Unique number	combine with the corresponding outcome measures by a common tsgrpid
Study Primary Objective; Trial Primary Objective	OBJPRIM	C85826	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@text	Objective/@level /code/@Code = C85826 ("Study Primary Objective") Objectives are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of OBJPRIM.	Add Unique number	combine with the corresponding outcome measures by a common tsgrpid
Study Secondary Objective; Trial Secondary Objective	OBJSEC	C85827	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@text	Objective/@level /code/@Code = C85827 ("Study Secondary Objective") Objectives are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of OBJSEC.	Add Unique number	combine with the corresponding outcome measures by a common tsgrpid
Exploratory Outcome Measure	OUTMSEXP	C98724	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@endpoints /Endpoint/@text	Endpoint/@level /code/@Code = C170559 ("Exploratory Endpoint") Endpoints are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of OUTMSEXP. Alternatively, the referenced biomedical concept can be used for OUTMSEXP.	Add Unique number	combine with the corresponding objective by a common tsgrpid
Primary Outcome Measure	OUTMSPRI	C98772	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives	Endpoint/@level /code/@Code = C94496 ("Primary Endpoint")	Add Unique number	combine with the corresponding objective by a common tsgrpid

TSPARM	TSPARMCD	Code	Codelist Code	TSVAL USDM Path and Attribute	Selection / Derivations	TSSEQ	TSGRPID
				/Objective/@endpoints /Endpoint/@text	Endpoints are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of OUTMSPRI. Alternatively, the referenced biomedical concept can be used for OUTMSPRI.		
Secondary Outcome Measure	OUTMSSEC	C98781	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@endpoints /Endpoint/@text	Endpoint/@level /code/@Code = C139173 ("Secondary Endpoint") Endpoints are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of OUTMSSEC. Alternatively, the referenced biomedical concept can be used for OUTMSSEC.	Add Unique number	combine with the corresponding objective by a common tsgrpid
Pharmacologic Class	PCLAS	C98768	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/ @pharmacologicClass	Corresponding @productDesignation should correspond to IMP		If applicable, combine with the corresponding intervention variables by a common tsgrpid
Anticipated Enrollment; Planned Enrollment; Planned Number of Subjects; Target Enrollment	PLANSUB	C49692	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/ @plannedEnrollmentNumber /Range/@MinValue + @MaxValue	Combine MinValue and MaxValue. If equal or only 1 available then only show once.		
Planned Treatment Duration	PTRTDUR	C139276	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@administrations /AgentADministration/@duration /AdministrationDuration/@quantity /Quantity/@value + @unit			If applicable, combine with the corresponding intervention variables by a common tsgrpid
Trial is Randomized	RANDOM	C25196	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@characteristics /code/@decode	If characteristics include "RANDOMIZED" then TSVAL="Y" and TSVALCD="C49488" Otherwise TSVAL="N" and TSVALCD="C49487"		
Rare Disease Indicator	RDIND	C126070	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@indications /Indication/@isRareDisease	If True then TSVAL="Y" and TSVALCD="C49488" If False then TSVAL="N" and TSVALCD="C49487"		
Registry Identifier	REGID	C98714	C66738	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier	..StudyIdentifier/@studyIdentifierScope /Organization/@type /Code/@code=C93453 ("Clinical Study Registry") Fill TSVCDREF with corresponding organization name. ..studyIdentifier/@studyIdentifierScope /Organization/@name	Add Unique number if more than 1	
Route of Administration	ROUTE	C38114	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@administrations /AgentAdministration/@route			
Sex of Participants	SEXPOP	C49696	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/@plannedSex			
Clinical Study Sponsor; Sponsor; Study Sponsor	SPONSOR	C70793	C66738	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifierScope /Organization/@name	..Organization/@type /Code/@code=C70793 ("Clinical Study Sponsor") TSVALCD=..Organization/@identifier TSVCDREF=..Organization/@identifierScheme		

TSPARM	TSPARMCD	Code	Codelist Code	TSVAL USDM Path and Attribute	Selection / Derivations	TSSEQ	TSGRPID
Sponsor's Study Reference ID	SPREFID	C135009	C66738	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier	..StudyIdentifier/@studyIdentifierScope /Organization/@type /Code/@code=C70793 ("Clinical Study Sponsor")		
Study Type; Study Type Classification	STYPE	C142175	C66738	Study/@versions /StudyVersion/@studyType			
Study Blinding Design; Study Blinding Schema; Study Masking Design; Trial Blinding Design; Trial Blinding Schema; Trial Masking Design	TBLIND	C49658	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@blindingSchema			
Control Type	TCNTRL	C49647	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@role	..StudyIntervention/@productDesignation/ Code/@Decode="NIMP" Map valid values of @role to TCNTRL		
Therapeutic Area	THERAREA	C101302	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@therapeuticAreas			
Trial Intent Type	TINDTP	C49652	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@trialIntentTypes		Add Unique number if more than 1	
Official Study Title; Study Title; Trial Title	TITLE	C49802	C66738	Study/@versions /StudyVersion/@titles /StudyTitle/@Text	..StudyTitle/@Type/Code/@decode="Official Study Title"		
Trial Phase; Trial Phase Classification	TPHASE	C48281	C66738	Study/@versions /StudyVersion/@studyPhase /AliasCode/@standardCode			
Investigational Therapy or Treatment	TRT	C41161	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyInterventions /StudyIntervention/@name	..StudyIntervention/@role/ Code/@Code="C41161"		If applicable, combine with the corresponding intervention variables by a common tsgrpid
Trial Scope; Trial Type	TTYPE	C49660	C66738	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@trialTypes		Add Unique number if more than 1	

7.2 Informing ClinicalTrials.gov Registry

The ClinicalTrials.gov registry can largely be filled with the study design information captured in the USDM. The definitions for protocol registration data elements submitted to ClinicalTrials.gov for interventional studies (clinical trials) and observational studies are provided on the corresponding definitions site. Included topics and whether they are covered in USDM are presented in the table below.

CT.gov topic	USDM coverage
Study Identification	Yes
Study Status	No; not available at study design stage
Sponsor/Collaborators	No
Oversight	No
Study Description	No; protocol text covered by the Unstructured Content (See Section 4.20) class may be used for this.
Conditions and Keywords	No
Study Design	Yes; Interventional Study design parameters
Arms, Groups, and Interventions	Yes
Outcome Measures	Yes
Eligibility	Yes; Interventional Study design parameters
Contacts, Locations, and Investigator Information	Limited; not presented in this overview
IPD Sharing Statement	No
References	No

The mapping for the required data elements of topics that are covered is specified below.

The mapping to **Study Identification** is presented below. See Section 4.7, Study Identifiers and Titles, for a description of the related features in the USDM.

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Selection/Derivation
Study Identification	Brief Title	Required	Study/@versions /StudyVersion/@titles /StudyTitle/@Text	..StudyTitle/@Type/Code/@decode="Brief Study Title" limit to 300 characters
Study Identification. Brief Title	Acronym	Required, If available	Study/@versions /StudyVersion/@titles /StudyTitle/@Text	..StudyTitle/@Type/Code/@decode="Study Acronym" limit to 14 characters
Study Identification	Official Title	Required	Study/@versions /StudyVersion/@titles /StudyTitle/@Text	..StudyTitle/@Type/Code/@decode="Official Study Title" limit to 600 characters
Study Identification	Secondary ID	Required, If available	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier	..StudyIdentifier/@studyIdentifierScope /Organization/@type /Code/@code <> C70793 ("Clinical Study Sponsor") ..studyIdentifier/@studyIdentifierScope /Organization/@name <> "NCT" (or NCT alias)
Study Identification. Secondary ID	Type	Required, If secondary ID available	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifierScope /Organization/@name	Map organization name to corresponding CT.gov terminology.

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Selection/Derivation
Study Identification. Secondary ID	Description	Required, If secondary ID available	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifierScope /Organization/@name	
Study Identification	Study Type	Required	Study/@versions /StudyVersion/@Type /code/@decode	In case of "PATIENT REGISTRY" in USDM, map to "Observational" in CT.gov. Other Study types can be submitted as is.

The mapping to **Study Design, interventional study design parameters** is presented below. See Section 4.6, Study, Protocols, and Amendments, for a description of the related features in the USDM.

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Required USDM relationship	Selection/Derivation
Study Design. Interventional Study Design	Primary Purpose	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@trialTypes /code/@decode		See Primary objective: .. /StudyDesign/@objectives /objective/@text where /StudyDesign/@objectives /objective/@level /code/@code=C85826 Select the TrialType that relates to the primary objective. There are 2 options to do this: • repeat of decode terminology in objective text • reference from primary objective text to corresponding trialtype instance
Study Design. Interventional Study Design	Study Phase	Required	Study/@versions /StudyVersion/@studyPhase /AliasCode/@standardCode /code/@decode		Remove "A" and "B" from SDTM terminology (codelist C66737) and map 1 to 1 to CT.gov terminology if possible.
Study Design. Interventional Study Design	Interventional Study Model	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@interventionModel /code/@decode		Translate CROSS-OVER to CROSSOVER. Other decode values from SDTM terminology (codelist C99076) can be submitted as is.
Study Design. Interventional Study Design. Interventional Study Model	Model description		study/@versions /studyVersion/@documentVersion studyProtocolDocumentVersion/@contents /NarrativeContent/@text		...NarrativeContent/@sectionTitle="Intervention Model" limit to 1000 characters
Study Design. Interventional Study Design	Number of Arms	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm		Count number of instances (each instance is an arm) defined in StudyArm class
Study Design. Interventional Study Design	Masking	Required	Study/@versions / StudyVersion/@studyDesigns /StudyDesign/@maskingRoles /Masking/@role /code/@decode		If no masking roles are defined in USDM then set Masking to 'No Masking'. If masking role in USDM = 'Sponsor' then leave empty. All other values can be submitted as is
Study Design. Interventional Study Design. Masking	Masking Description		Study/@versions / StudyVersion/@studyDesigns /StudyDesign/@maskingRoles /Masking/@role /code/@decode + @description		If masking role in USDM = 'Sponsor' then fill with 'Sponsor' + corresponding description.
Study Design. Interventional Study Design	Allocation	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm and Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@characteristics /code/@decode		Count number of instances (each instance is an arm) defined in StudyArm class. If 1 or less then submission value is "N/A (not applicable)". Else If characteristics include "RANDOMIZED" then submission value is "Randomized" Otherwise submission value is "Nonrandomized"

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Required USDM relationship	Selection/Derivation
Study Design. Interventional Study Design	Enrollment	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/@plannedEnrollmentNumber /Range/@MinValue + @MaxValue		Combine MinValue and MaxValue. If equal or only 1 of them available then only show once.

The mapping to **Arms, Groups and Interventions** is presented below. See Section 4.10, Arms and Epochs, and Section 4.16, Study Interventions, for descriptions of the related features in the USDM.

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Required USDM relationship	Selection/Derivation
Arms, Groups and Interventions. Arm Information	Arm Title	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm/@name		Limit to 100 characters.
Arms, Groups and Interventions. Arm Information	Arm Type	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm/@type /code/@decode		In case USDM arm types "Control" and "Treatment" are used they may be mapped to "Other" or any of the Experimental or Comparator types. All other USDM arm types can directly be used by moving the word "arm" from the USDM arm decode value.
Arms, Groups and Interventions. Arm Information	Arm Description	If needed	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm/@description		Limit to 999 characters.
Arms, Groups and Interventions. Group/Cohort Information	Group/Cohort Label	For observational studies only	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population / StudyDesignPopulation/@cohorts /StudyCohort/@label		Limit to 100 characters.
Arms, Groups and Interventions. Group/Cohort Information	Group/Cohort Description	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population / StudyDesignPopulation/@cohorts /StudyCohort/@description		Limit to 999 characters.
Arms, Groups and Interventions. Interventions	Intervention Type	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@elements /StudyElement/@studyInterventions /StudyIntervention/@type /Code/@decode	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@StudyArm	StudyCell relates StudyArm with corresponding element that relates to the corresponding intervention. From CT.gov: "If the same intervention is associated with more than one arm or group, provide the information once and use the Arm or Group/Intervention Cross-Reference to associate it with more than one arm or group." Text transformation is needed for 1 to 1 mapping to CT.gov terminology.
Arms, Groups and Interventions. Interventions	Intervention Name	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@elements		Limit to 200 characters.

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Required USDM relationship	Selection/Derivation
			/StudyElement/@studyInterventions /StudyIntervention/@name		
Arms, Groups and Interventions. Interventions	Other Intervention Name	If any	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@elements /StudyElement/@studyInterventions /StudyIntervention/@label		Upon judgement of (system) user to decide whether label should be included as other intervention name. Limit to 200 characters.
Arms, Groups and Interventions. Interventions	Intervention Description	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@elements /StudyElement/@studyInterventions /StudyIntervention/@description		Limit to 1000 characters.
Arms, Groups and Interventions. Interventions	Arm or Group/Interventional Cross-References	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@elements /StudyElement/@studyInterventions /StudyIntervention/	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@StudyArm	From Ct.gov: "If the same intervention is associated with more than one arm or group, provide the information once and use the Arm or Group/Intervention Cross-Reference to associate it with more than one arm or group."

The mapping to **Outcome Measures** is presented below. See Section 4.16, Study Objectives and Endpoints, for a description of the related features in the USDM.

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Required USDM relationship	Selection/Derivation
Outcome Measures. Primary Outcome Measure Information	Title	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@name		.. /Endpoint/@level /code/@code=C94496 Limit to 254 characters.
Outcome Measures. Primary Outcome Measure Information	Description	If available	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@text		.. /Endpoint/@level /code/@code=C94496 The endpoint text is based on the SyntaxTemplate class (see Section 4.21). Referenced values need to be replaced by actual values before submitting. Limit to 999 characters.
Outcome Measures. Primary Outcome Measure Information	Time Frame	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@text	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@scheduleTimelines /ScheduleTimeline/@ScheduleInstance /Timing/@value	.. /Endpoint/@level /code/@code=C94496 In case of reference to the corresponding Timing class, check and use the referenced timing for this attribute. Limit to 254 characters.
Outcome Measures. Primary Secondary	Title	If any	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@name		.. /Endpoint/@level /code/@code=C139173 Limit to 254 characters.

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Required USDM relationship	Selection/Derivation
Measure Information					
Outcome Measures. Primary Secondary Measure Information	Description	If available	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@text		.. /Endpoint/@level /code/@code=C139173 The endpoint text is based on the SyntaxTemplate class. Referenced values need to be replaced by actual values before submitting. Limit to 999 characters.
Outcome Measures. Primary Secondary Measure Information	Time Frame	If any	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@text	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@scheduleTimelines /ScheduleTimeline/@ScheduleInstance /Timing/@value	.. /Endpoint/@level /code/@code=C139173 In case of reference to the corresponding Timing class, check and use the referenced timing for this attribute. Limit to 254 characters.
Outcome Measures. Other Pre-specified Outcome Measures	Title	If any	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@name		.. /Endpoint/@level /code/@code=C170559 Limit to 254 characters.
Outcome Measures. Other Pre-specified Outcome Measures	Description	If available	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@text		.. /Endpoint/@level /code/@code=C170559 The endpoint text is based on the SyntaxTemplate class. Referenced values need to be replaced by actual values before submitting. Limit to 999 characters.
Outcome Measures. Other Pre-specified Outcome Measures	Time Frame	If any	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /objective/@endpoints /Endpoint/@text	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@scheduleTimelines /ScheduleTimeline/@ScheduleInstance /Timing/@value	.. /Endpoint/@level /code/@code=C170559 In case of reference to the corresponding Timing class, check and use the referenced timing for this attribute. Limit to 254 characters.

The mapping to **Eligibility** is presented below. See Section 4.19, Populations, Cohorts and Eligibility Criteria, for a description of the related features in the USDM.

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Required USDM relationship	Selection/Derivation
Eligibility. Sex/Gender	Sex	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/@plannedSex /code/@decode		Map 1 to 1 to corresponding ct.gov terminology.
Eligibility. Sex/Gender	Gender Based	If applicable	Not in USDM v3.0		CT.gov: "Gender means a person's self-representation of gender identity." In general, it can be decided whether this is 'No' for all trials governed by the sponsor.
Eligibility. Sex/Gender	Gender Eligibility Description		Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyPopulation/@criteria/ EligibilityCriteria/@text	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/@plannedSex	The eligibility text is based on the SyntaxTemplate class (see Section 4.21). Referenced values need to be replaced by actual values before

CT.gov Path	CT.gov Variable	CT.gov Requirement	USDM path and attribute	Required USDM relationship	Selection/Derivation
					submitting. Limit to 1000 characters. Select the criterium referencing to the corresponding plannedSex value, if any.
Eligibility. Age Limits	Minimum Age	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyPopulation/@plannedAge / Range/@minValue		
Eligibility. Age Limits	Unit of Time	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyPopulation/@plannedAge / Range/@unit / code/@decode		Map 1 to 1 to corresponding ClinicalTrials.gov terminology.
Eligibility. Age Limits	Maximum Age	Required	RequiredStudy/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyPopulation/@plannedAge / Range/@maxValue		
Eligibility. Age Limits	Unit of Time	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyPopulation/@plannedAge / Range/@unit / code/@decode		Map 1 to 1 to corresponding ClinicalTrials.gov terminology.
Eligibility	Accepts Healthy Volunteers	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation /StudyCohort/@includesHealthySubjects		If any of the values for the StudyDesignPopulation or a StudyCohort is True then set to 'Yes'. Otherwise set to 'No'
Eligibility	Eligibility Criteria	Required	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyPopulation/@criteria/ EligibilityCriteria/@text		The eligibility text is based on the SyntaxTemplate class. Referenced values need to be replaced by actual values before submitting. Select limited list for submission and limit to 20000 characters.
Eligibility	Study Population Description	For observational studies only	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/@description		Limit to 1000 characters.
Eligibility	Sampling Method	For observational studies only	Not in USDM v3.0		

7.3 Use of USDM for Populating Protocol Content

A secondary aim of the USDM is to demonstrate that protocol-related content can be pulled from a reference implementation of the USDM and populated programmatically into the corresponding fields of a structured document. A successful demonstration is anticipated to facilitate expanding future versions of the USDM for this purpose. The TransCelerate CPT was selected to conduct this proof of concept (POC) because it is a publicly available resource proposed to harmonize clinical trial protocol content in a streamlined format. The POC exercise relied on a prioritized set of structured fields within the CPT for content introduced in USDM v1.0 and extended in USDM v2.0. The following table lists a selection of structured CPT field names mapped to USDM which were used in the POC. The paths and attribute references and corresponding selection/derivations have been adapted to USDM v3.0 to allow users using the mapping below with this new version. However, new features of USDM v3.0 are not included in this list.

CPT Section	CPT Variable Display Name	CPT Variable Name (compacted)	CPT Var Type	Mapping Type	USDM Path and Attribute	USDM Field Type	Selection / Derivations
Synopsis	Number of Participants	CPT:NumberofParticipants	Text	OneToOne	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/@plannedEnrollmentNumber /Range/@MinValue + @MaxValue	Integer	Combine MinValue and MaxValue. If equal or only 1 available then only show once.
Study Rationale	Study Rationale	CPT:StudyRationale	Rich Text	OneToOne	Study/@versions /StudyVersion/@Rationale	Text	
Objectives and Endpoints	Objectives Endpoints and Estimands	CPT:ObjectivesEndpointsAndEstimands	RichText	OneToMany	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@text Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@endpoints /Endpoint/@text Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@estimands	Text	See below fields.
Objectives and Endpoints	Primary Endpoints	CPT:EndpointsPrimary	RichText	OneToMany	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@endpoints /Endpoint/@text	Text	Endpoint/@level /code/@Code = C94496 ("Primary Endpoint") Endpoints are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of EndpointsPrimary. They can be grouped with the corresponding objective via the objective-endpoint relationship.
Objectives and Endpoints	Primary Objectives	CPT:ObjectivesPrimary	RichText	OneToMany	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@text	Text	Objective/@level /code/@Code = C85826 ("Study Primary Objective") Objectives are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of ObjectivesPrimary
Objectives and Endpoints	Secondary Endpoints	CPT:EndpointsSecondary	RichText	OneToMany	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@endpoints /Endpoint/@text	Text	Endpoint/@level /code/@Code = C139173 ("Secondary Endpoint") Endpoints are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of EndpointsSecondary. They can be grouped with the corresponding objective via the objective-endpoint relationship.
Objectives and Endpoints	Secondary Objectives	CPT:ObjectivesSecondary	RichText	OneToMany	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@objectives /Objective/@text	Text	Objective/@level /code/@Code = C85827 ("Study Secondary Objective") Objectives are based on the SyntaxTemplate class. References values need to be replaced by actual values before creation of ObjectivesSecondary.
Scientific Rationale for Study Design	Scientific Rationale for Study Design	CPT:ScientificRationaleforStudyDesign	RichText	OneToOne	Study/@versions /StudyVersion/@studyDesigns/ StudyDesign/@Rationale	Text	Retrieve studyDesignRationale value
Inclusion Criteria	Planned Maximum Age of Subjects	CPT:PlannedMaximumAgeofSubjects	Text	ManyToOne	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation |StudyCohort/@plannedAge /Range/@maxValue + @unit	Text	Use maximum of maximum age values of all populations included (studyDesignPopulations and Cohorts). Transform according to ISO 8601 standards. If 1 or more populations have a null maxValue then TSVAL should be set to null and TSVALNF should be filled instead according to ISO 21090.
Inclusion Criteria	Planned Minimum Age of Subjects	CPT:PlannedMinimumAgeofSubjects	Text	ManyToOne	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population (/StudyDesignPopulation/@cohorts) /StudyDesignPopulation |StudyCohort/@plannedAge /Range/@minValue + @unit	Text	Use minimum of minimum age values of all populations included (studyDesignPopulations and Cohorts). Transform according to ISO 8601 standards. If 1 or more populations have a null minValue then TSVAL should be set to null and TSVALNF should be filled instead according to ISO 21090.

CPT Section	CPT Variable Display Name	CPT Variable Name (compacted)	CPT Var Type	Mapping Type	USDM Path and Attribute	USDM Field Type	Selection / Derivations
Inclusion Criteria	Sex of participants	CPT:Sexofparticipants	Choice	vs.CodeList	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@population /StudyDesignPopulation/@plannedSex /code/@decode	Code[]	Refer to CDISC codelist for Sex and corresponding eCPT mapping values in Data mapping sheet
Study Interventions Administered	Arm Description	CPT:ArmDescription	RichText	OneToOne ManyToOne	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm/@description	Text	studyArmDescription, ArmName and Decode Value of ArmType to be sent as an arrayList in response.
Study Interventions Administered	Arm Name	CPT:ArmName	RichText	OneToOne	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm/@name	Text	studyArmDescription, ArmName and Decode Value of ArmType to be sent as an arrayList in response.
Study Interventions Administered	Arm Type	CPT:ArmType	RichText	OneToOne	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@arms /StudyArm/@type /code/@decode	Code	studyArmDescription, ArmName and Decode Value of ArmType to be sent as an arrayList in response.
Study Interventions Administered	Intervention Description	CPT:InterventionDescription	RichText	OneToOne	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@studyCells /StudyCell/@elements /StudyElement/@studyInterventions /StudyIntervention/@description	Code[]	Other fields (e.g., intervention name, type, dosage) are available in USDM v3.0. They are not included in the mapping but can be derived using the same route.
Populations for Analyses	Populations for Analyses	CPT:PopulationsForAnalyses	RichText	ManyToOne	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@estimands /AnalysisPopulation/@name + @description	Text	Retrieve all (distinct) analysisPopulation names and corresponding descriptions as comma separated (e.g., Desc1, Desc2, Desc3)
Page Header	Version Number	CPT:VersionNumber	Text	OneToMany	Study/@versions /StudyVersion/@documentVersion /studyProtocolDocumentVersion/protocolVersion	Text, text	protocolVersion sort by EffectiveDate and Version
Protocol and Brief Title	Condition or Disease	CPT:ConditionDisease	Text	OneToMany	Study/@versions /StudyVersion/@studyDesigns /StudyDesign/@indications /indication/@name + @description	Text	Retrieve all indicationDescriptions as comma separated (e.g., Desc1, Desc2, Desc3)
Title Page	Acronym	CPT:Acronym	Text	OneToOne	Study/@versions /StudyVersion/@titles /StudyTitle/@Text	Text	..StudyTitle/@Type/Code/@decode="Study Acronym"
Title Page	Amendment Number	CPT:AmendmentNumber	Text	OneToMany	Study/@versions /StudyVersion/@amendments /StudyAmendment/@number	Text	protocolAmendment: use previous for sorting
Title Page	Protocol Short Title	CPT:ProtocolShortTitle	RichText	OneToOne	Study/@versions /StudyVersion/@titles /StudyTitle/@Text	Text	..StudyTitle/@Type/Code/@decode="Brief Study Title"
Title Page	Protocol Title	CPT:ProtocolTitle	RichText	OneToMany	Study/@versions /StudyVersion/@titles /StudyTitle/@Text	Text	..StudyTitle/@Type/Code/@decode="Official Study Title"
Title Page	Regulatory Agency ID	CPT:RegulatoryAgencyID	Choice	vs.CodeList	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifierScope /Organization/@identifierScheme	Code	Retrieve organisationIdentifierScheme where Type = "Regulatory Agency" (first element to be considered if multiple array elements)
Title Page	Regulatory Agency Number	CPT:RegulatoryAgencyNumber	Text	OneToMany	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifier	Text, text	Retrieve studyIdentifier where Type = "Regulatory Agency"'(first element to be considered if multiple array elements)
Title Page	Sponsor Legal Address	CPT:SponsorLegalAddress	Text	OneToOne	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifierScope /Organization/@legalAddress /Address/@text+@line+@district+ @city+@postalCode+@state	Text	Where Organization Type=Clinical Study Sponsor. Concatenate all Address properties. Take First value if there are more than 1.
Title Page	Sponsor Name	CPT:SponsorName	Text	OneToOne	Study/@versions /StudyVersion/@studyIdentifiers /StudyIdentifier/@studyIdentifierScope /Organization/@name	Text	Where Organization Type=Clinical Study Sponsor.
Title Page	Study Phase	CPT:StudyPhase	Choice	vs.CodeList	Study/@versions /StudyVersion/@studyPhase /AliasCode/@standardCode /code/@decode	aliasCode	Retrieve decode Value from standardCode element. Transform into CPT master code value

8 Appendices

Appendix A: USDM Team

Name	Institution/Organization
John Owen	Project Manager, CDISC
Dave Iberson-Hurst	USDM Product Owner, CDISC
Berber Snoeijer	USDM Technical Team Lead, CDISC
Erin Muhlbradt	Controlled Terminology Expert, NCI-EVS
Craig Zwickl	Controlled Terminology Expert, CDISC
Gerry Campion	Senior Software Engineer, CDISC

The USDM has been developed in partnership with TransCelerate Biopharma and Accenture. CDISC would like to acknowledge the support and input from the following groups:

- TransCelerate DDF Core Team
- TransCelerate member company subject-matter experts
- Accenture DDF development team
- CDISC DDF volunteer teams and volunteer vendor organizations

Appendix B: Glossary and Abbreviations

The following abbreviations and terms are used in this document. Additional definitions can be found in the CDISC Glossary (available at http://www.cdisc.org/glossary/index.html).

ADaM	Analysis Data Model
API	Application programming interface
BRIDG	Biomedical Research Integrated Domain Group
BC	Biomedical concept: A unit of biomedical knowledge created from a unique combination of characteristics that include implementation details like variables and terminologies, used as building blocks for standardized, hierarchically structured clinical research information
CDASH	Clinical Data Acquisition Standards Harmonization Project
CDISC	Clinical Data Interchange Standards Consortium
CeSHarP	(ICH) Clinical Electronic Structured Harmonised Protocol
Collected	"Collected" refers to information that is recorded and/or transmitted to the sponsor. This includes data entered by the site on CRFs/eCRFs as well as vendor data such as core lab data. This term is a synonym for "captured."
CPT	(TransCelerate) Common Protocol Template
CRF	Case report form (sometimes, case record form): A printed, optical, or electronic document designed to record all required information to be reported to the sponsor for each trial subject
CT	Controlled terminology: A finite set of values that represent the only allowed values for a data item. These values may be codes, text, or numeric. A codelist is a type of controlled terminology.
CTR	Clinical Trial Registry
DDF	Digital Data Flow (project)
Domain	A collection of observations with a topic-specific commonality about a subject
eCRF	Electronic case report form
ECG	Electrocardiogram
EDC	Electronic data capture
EHR	Electronic health record
EMA	European Medicines Agency
ePRO	Electronic patient-reported outcome
EudraCT	European Union Drug Regulating Authorities Clinical Trial Database
FDA	(US) Food and Drug Administration
FHIR	(HL7) Fast Healthcare Interoperability Resources
Foundational standards	The suite of CDISC standards that describe the clinical study protocol (Protocol), design (Study Design), data collection (CDASH), laboratory work (Lab), analysis (ADaM), and data tabulation (SDTM and SEND); http://www.cdisc.org/
GARD	(NIH) Genetic and Rare Diseases Information Center
GENC	(FDA) Geopolitical Entities, Names and Codes
HL7	Health Level Seven International
HTML	HyperText Markup Language
ICE	Intercurrent events; events that occur after randomization and alter the course of the randomized treatment during the intended study treatment period
ICD	International Classification of Diseases
ICH	International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use
JSON	JavaScript Object Notation

LOINC	Logical Observation Identifiers Names and Codes
MedDRA	Medical Dictionary for Regulatory Activities. A global standard medical terminology designed to supersede, in regulatory submissions, other terminologies previously used in the medical product development process (such as COSTART and ICD9).
MeSH	Medical Subject Headings (thesaurus)
NCI EVS	(NIH) National Cancer Institute Enterprise Vocabulary Services
NIH	National Institutes of Health
ODM	Operational Data Model
Patient	A recipient of medical treatment
PDF	Portable data format
PHR	Personal health record
POC	Proof of concept
POV	Proof of viability
PRM	Protocol Representation Model
PRO	Patient-reported outcome
SDM-XML	Study/Trial Design Model in XML
SDR	Study Definitions Repository
SDTM	Study Data Tabulation Model
SDTMIG	SDTM Implementation Guide (for Human Clinical Trials)
SEND	Standard for the Exchange of Nonclinical Data
SME	Subject-matter expert
SNOMED	Systemized Nomenclature of Medicine
SOA	Schedule of activities
SSU	Study start-up
Subject	A participant in a study
UML	Unified modeling language
USDM	United Study Definitions Model
USDM-IG	USDM Implementation Guide
UUID	Universally unique identifier
WHO	World Health Organization
XML	Extensible markup language

Appendix C: References

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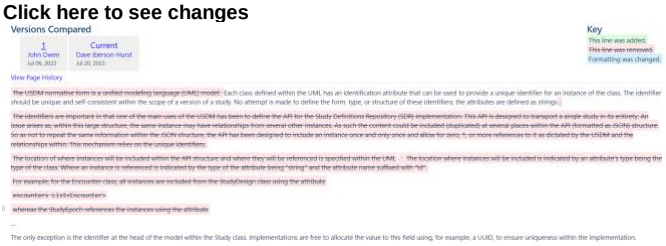
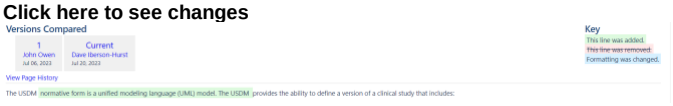
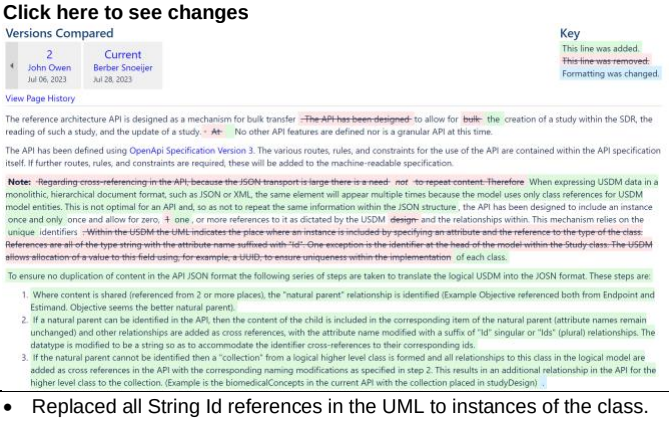
Appendix D: Revision History

USDM Implementation Guide

The USDM v1.0 was released as part of the DDF Reference Architecture in August 2022. Version v1.0 of the USDM has no associated implementation guide therefore there is no revision history for the Implementation Guide. The first version of the USDMIG is therefore v2.0. This section details the changes made to the USDMIG between v2.0 and v3.0.

Amendments between USDM v2.0 and USDM v3.0

#	Release #	Overview	Notes
1	**2.1**	Created Naming Conventions section	1. This section details the conventions used for naming and the use of attribute datatypes 2. To support model split and element renaming
2		Edits to Internal Identifiers Within the Model	1. To support model split and element renaming **Click here to see changes** 
3		Edits to Overview	1. To support model split and element renaming **Click here to see changes** 
4		Edits to USDM API	1. To support model split and element renaming **Click here to see changes** 
5		UML Split Model and Model Naming Changes	• Replaced all String Id references in the UML to instances of the class. • Changed all class properties for Id, Name and Description to consistent across the model. Removed the class name prefix from these properties.
6	**2.3**	Add section "Unstructured Content" to the USDM Features section of the Implementation Guide	Added new section for unstructured content 1. This section introduces the content class that is used to store unstructured narrative content.
7		Add section "Syntax Templates" to the USDM Features section of the Implementation guide.	1. This section introduces the classes that enable syntax text templates 2. It explains the how the syntax text templates can be used in the USDM 3. It explains how references can be made to data elements stored elsewhere in the data model.

#	Release #	Overview	Notes
			4. It gives examples of text templates and corresponding examples.
8		Added label to Naming Conventions section.	
9	**2.4**	Change class name "Content" to "Narrative Content" in the Unstructured Content section of USDM Features	
10	**2.8**	Update to CT section	Added detail on standard codes and alias code
11		inserted Principles section	Added notes on principles. Needs further work
12		Update to API section	Improved text within API section and added details re the "instanceType" attribute
13		Update to Arms and Epoch section	Small updates to text, inserted UML and added links to related pages.
14		Update to Activities section	Small updates to text, inserted UML, added conditional class information and added links to related pages.
15		Update to Study Population section	Updates to text in accordance with model changes, added UML and cohort and eligibility description.
16		Update to Intervention section	updates to text in accordance with model changes and added UML
17		Added new section Addressing Footnotes	identified 12 types of footnotes and describing how they can be included in the USDM
18		Updated section Study Timing	Added UML, updated text and timeline figures
19		Updated section Relationship to Other CDISC Standards	Moved mapping to SDTM trial summary domains to Creation of SDTM Trial Design Domains
20		Updated USDM Team	Updated USDM Team page to include the latest team members for USDM v3.0
21		Added Creation of SDTM Trial Design Domains	
22		Updated Study, Version, Identifier section	Changed title to Study, Protocols, and Amendments. Added UML and description of protocol and amendment versions. Identifiers will be handled in new section.
23		Updated Syntax Templates	Updated content according to html reference style
24		Added Study Identifiers and Titles	Moved description of Study Identifiers here and added Titles description
25		Updated Procedures	Added reference to study intervention. Removed conditionality which is described more general for all related classes in Activities
26		Updated Indications	Added description of new attribute isRareDisease
27		Updated Study Objectives and Endpoints	Inserted UML and reference to syntax template class
28		Updated Study Estimands	updated reference names
29	**2.9**	Updated Fundamentals of the USDM	Added information on v3.0
30		Updated Arms and Epochs	Added link to Creation of SDTM Trial Design Domains
31		Updated Study Timing	Replaced UML based on changed relationship to timing class. Some minor textual changes.
32		Updated Study Objectives and Endpoints	Replaced UML based on changed reference name from Estimand to studyIntervention class.
33		Updated Populations, Cohorts and Eligibility Criteria	Replaced UML based on chanced name of EligibilityCriterion class and small textual updates.
34		Updated Use of USDM for Populating Protocol Content	Adapted the POC mapping to v3.0 of USDM. No additional variables are mapped based on new features of USDM v3.0. This is indicated in the introduction.
35		Updated Study, Protocols, and Amendments	Removed study site information from UML and descriptions. Moved to new paragraph: Organizations
36		Added Organizations	Added UML and description of Organization class and corresponding research Organization and sites.

Amendments between USDM v1.0 and USDM v2.0 (UML, CT, API)

The following table lists at a high level the major changes that occurred between USDM v1.0 and USDM v2.0

#	Sprint #	Overview	Notes
1	1	Bugfixes and review comments from DDF Phase I	1. StudyEpoch Class: Add encounters relationship, 1 -> 0..* 2. IntercurrentEvent Class: strategy attribute rename to "intercurrentEventStrategy" and is of type String 3. PointInTime Class: remove from the model 4. Encounter Class Attributes "startRule" and "endRule" should be renames and prefixed with "transition", so "transitionStartRule", "transitionEndRule" 5. Workflow Class Attribute "workflowId" renamed to "uuid"

#	Sprint #	Overview	Notes
			6. Estimand Class Attribute "variableOfInterest" type should be Endpoint not Encounter
2	1	Addition of Therapeutic Area	1. Class: Study Attribute businessTherapeuticArea 2. Class: StudyDesign Attribute therapeuticAreas
3	1	Allow for multiple trial types entries on the StudyDesign class	1. Class StudyDesign Attribute trialType amended to a list
4	2	Terminology Flexibility	1. Code and CodeAlias classes added to the model
5	2	Addition of name and description for StudyDesign class	1. Class: StudyDesign Attribute studyDesignName 2. Class: StudyDesign Attribute studyDesignDescription
7	3	Attribute name changes	1. Class: Study Attribute: studyIdentifier amended to studyIdentifiers 2. Class: Study Attribute: studyProtocolVersion amended to studyProtocolVersions 3. Class: Study Attribute: studyDesign amended to studyDesigns
9	3	Visit Contact Mode	1. Not sure what has changed here
10	4	Allow Study Phase to use the Code Alias	1. Class: Study Attribute studyPhase amended from Code to AliasCode
10	4	Add flag for Activity and Procedures being optional	1. Class: Activity Attribute activityIsOptional added 2. Class: Procedure Attribute procedureIsOptional added 3. Also see additional change to 16 below
12	5	Additional elements added in to support eCPT population	1. Class: Study Attribute; studyRationale added 2. Class: Study Attribute: studyAcronym added 3. Class: StudyDesignPopulation Attribute: plannedNumberOfParticipants added 4. Class: StudyDesignPopulation Attribute: plannedMaximumAgeOfParticipants added 5. Class: StudyDesignPopulation Attribute: plannedMinimumAgeOfParticipants added 6. Class: StudyDesignPopulation Attribute: sexOfParticipants added 7. Class: StudyDesign Attribute: studyDesignRationale added 8. Class: Organization Attribute: organizationLegalAddress added
15	6	New class for Address	Class: Address added with the following attributes • Text • Line • City • District • State • Postal Code • Country
16	6	Amend activityIsOptional and procedureIsOptional to conditional	1. Class: Activity Attribute activityIsOptional amended to activityIsConditional 2. Class: Procedure Attribute procedureIsOptional amended to procedureIsConditional
17	6	Addition of TBLIND/Trial Blinding Schema (valid values in codelist C66735) code to studyDesignBlindingScheme	1. Class: StudyDesign Attribute studyDesignBlindingScheme codelist TBLIND added
19	7	Biomedical Concepts sub model added	See Section 4.9, Biomedical Concepts, for additional information. Addition of the following Classes (note that class StudyData was removed and replaced with the Biomedical Concept classes • BiomedicalConcept • BioemdcialConceptProperty • ResponseCode

#	Sprint #	Overview	Notes
			• BiomedicalConceptCategory • BiomedicalConceptSurrogate
20	9	Study Timing and "Timepoints" added to the model	See Section 4.10, Study Timing, for additional information. Addition of the following Classes (note that class StudyData was removed and replaced with the Biomedical Concept classes • ScheduleTimeline • Timing • ScheduledInstance • ScheduledDecisionInstance • ScheduledActivityInstance • ScheduleTimelineExit
21	11	Internal Review Sprint Changes	• API only: studyStudyDesignPopulations changed to studyPopulations • StudyEpoch.encounters type List<Encounter> Amended to StudyEpoch.encounter**Ids** type List<**String**> • StudyEpoch.trialIntentType type List<Code> Amended to StudyEpoch.trialIntentType**s** type List<Code> • Procedure.procedureName type String Added • Procedure.procedureDescription type String Added
22	11-14	Public Review Sprint Changes	• StudyEpoch.encounters type List<Encounter> changed to StudyEpoch.encounterIds type List<String> • StudyDesign.trialIntentType type List<Code> changed to StudyDesign.trialIntentTypes type List<Code> • Procedure.procedureDescription type String added • Procedure.procedureName type String added

As part of the v2.0 updates, the elements of the RA (USDM, CT, API, and IG) are stored within a Github repository and version managed as a series of releases corresponding to the sprints, a subsequent release for internal review, a release for public review, and a release for the final publication as v2.0.

- **Controlled Terminology:** For a complete list of controlled terminology changes between USDM v1.0 and the public review version, see the USDM_CT_Changes.xlsx file in the controlled terminology deliverable folder.
- **UML:** A list of changes to the UML model between USDM v2.0 and the public review version can be found here. A list of model changes between Internal Review and Public Review can be found here. A list of changes between Public Review and Publication can be found here.
- **API:** For a complete list of API changes between USDM v1.0 and USDM v2.0, use a file-comparison tool to compare the API from USDM v1.0 and the API for USDM v2.0. Please refer to the USDM API.yaml files in the API deliverable folder.

Amendments between USDM v2.0 and USDM v3.0

- **Controlled Terminology:** For a complete list of controlled terminology changes between USDM v2.0 and the public review version, see the USDM_CT_Changes.xlsx file in the controlled terminology deliverable folder.
- **UML:** A list of changes to the UML model between USDM v2.0 and the public review version can be found here.
- **API:** For a complete list of API changes between USDM v2.0 and USDM v3.0, use a file-comparison tool to compare the API from USDM v2.0. and the API for USDM v3.0 Please refer to the USDM API.yaml files in the API deliverable folder.

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