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Device Domains: Examples of their Use in Clinical Trials

Oksana Voevutska, Chiltern, Kyiv, Ukraine

ABSTRACT

Medical devices are increasingly used to treat different health conditions and save lives. Any instrument, apparatus, appliance, material or other article, including the software intended to be used on humans could be considered as a Device. Devices are used independently or combined with drugs or biologic agents. They play a significant role in treating subjects. It's important to standardize device measurements, events, and interventions during use of the device by the subject. SDTM Device domains provide guidelines for the standardization process.

The objectives of this presentation are to explain when to apply Device domains, illustrate different use case scenarios on how to standardize data collected by the device under study and to discuss the challenges of the standardization process. We will see interesting example of using the latest technologies, like mobile phones, in device studies.

INTRODUCTION

Today medical devices are an important part of the healthcare industry and are increasingly used in the medical world. Clinical trials with medical devices analyze the impact of the device on the subject or data collected by the device under study, so the device must be taken into account. In other words device-related data, as well as subject-related data, must be standardized.

Per the SDTMIG-MD [1] a "Medical Device" is
- Any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for its proper application, intended by the manufacturer to be used on human beings for the purpose of:
- diagnosis, prevention, monitoring, treatment or alleviation of disease,
- diagnosis, monitoring, treatment, alleviation or compensation for an injury or handicap,
- investigation, replacement or modification of the anatomy or of a physiological process,
- control of conception,

and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means.

Over the past years, the CDISC (Clinical Data Interchange Standards Consortium) Submission Data Standards (SDS) device team, has designed a set of supplemental device-related domains for the Study Data Tabulation Model (SDTM) to handle device data. Seven new domains were created to standardize the collected data related to medical devices. These domains cover different information such as identifiers, characteristics and settings used for each device in the study, details of device deployment or drug exposure and the recording of disposition events or other device-related events such as malfunction.

Most Class II and III devices require regulatory data submissions. Right now, standardized data submissions using CDISC standards are not yet mandated by CDRH. But, it is highly recommended to create the datasets in standardized format as specified in the CDISC guidelines. The device domains should be used when the investigational product under study is a medical device or if a device is used as an instrument to obtain the measurements or results of the study.

This paper presents an overview of main points of SDTM device domains and describes the application of these domains to study data obtained from two different studies. In the first case, the combination of device and treatment is under study and, in the second case, the objective of the trial is to investigate the influence of the device usage, but the device itself is not under the study. The observations made and methodologies proposed can be applied to a wide range of therapeutic areas.

THE MAIN POINTS OF DEVICE DOMAINS' ASSUMPTIONS

The collected data for the devices tabulated using SDTMIG-MG. All the other data that are not device-specific are created using the SDTM-IG version 3.2.

Device Identifiers (DI), Device Properties (DO), and Device In-Use (DU) domains describe a full set of essential device characteristics. Device Events (DE) and Device Tracking and Disposition (DT) domains record tracking and any events that occurred to the devices. Device Exposure (DX) and Device-Subject Relationship (DR) represent the details of device deployment and/or treatment and the device relationship to the subject, respectively.

DI – DEVICE IDENTIFIERS

Device Identifiers (DI) domain is a Special-Purpose domain that was designed to capture multiple identifiers such as model, serial number, lot identifier, manufacturer, etc. to create a single identifier (SPDEVID) for each device to link data across the device domains. DI contains only identifier characteristics that cannot be changed during the study. DI domain must exist if SPDEVID is used in any domain in a study.

- SPDEVID can be at any level of granularity – to identify an individual device or it may be used to specify only the type of device (for example, in studies where device is not the product under study and is used only to conduct assessments). SPDEVID is required to be present in all device domains.
- At least one identifier element (DIPARMCD='TYPE') must be populated for each device. TYPE uses controlled terminology defined by FDA as Global Medical Device Nomenclature (GMDN). However, for now it is not required because it is not freely available to the public.
- Device Identifiers exist independently from subjects and therefore the DI domain does not contain USUBJID.

DO – DEVICE PROPERTIES

Device Properties (DO) is a Findings domain which includes information about device characteristics that are important to include in the submission, that are not a part of the device identifier, and do not change during the course of the study. Examples of these characteristics include: expiration date, size, software version, indication for use, etc. DO should have one record per device property, a description that is stored in DOTEST (Device Property Test Name) and should correspond to the controlled terminology code list. This is a device-level domain. It contains only device properties and does not include USUBJID or any other timing variables.

DU – DEVICE IN-USE

Device In-Use, also Findings domain, stores specific properties and settings that are intentionally set on a device when it is used and can vary from subject to subject or usage to usage over the course of the study. Since these characteristics can be subject-level, the DU domain may use two primary identifiers: USUBJID and SPDEVID. Although both of them are expected variables, at least one must be populated. For example, if the device is under the study, USUBJID may or may not be populated, and in the case when the device is not under the study, SPDEVID may or may not be populated.

DX – DEVICE EXPOSURE

DX is an Interventions domain that contains information about a subject's exposure to a device or direct contact with the output from a medical device. This device may be used by the subject, on the subject or inside the subject (in the case of an implantable device). Examples include but are not limited to stents, drug delivery systems, and any other item under the study that is defined as a device in the applicable regulations.

DX is comparable to the EX (Exposure) domain from main SDTM model, however they represent different information. The purpose of DX is to present information about interaction between the subject and the device or device output (e.g. device deployment), meanwhile EX – references the amount of study drug to which the subject is exposed. Similarly to EX, the topic variable in DX is DXTRT which captures the name of the investigational treatment. DXTRT should avoid duplication of characteristics that are represented in DO (Device Properties) domain. Both identifier variables USUBJID and SPDEVID are required to be populated in DX.

DE – DEVICE EVENTS

Device Events is an Events domain that provides information about various kinds of device-related events, such as malfunctions, maintenance or parts replacement. DE is intended to capture events while the device is under the study, therefore it does not cover the events that occurred before the device was used in the study (e.g., during a transportation).

- DE domain should have one record per event per device, although if an event impacts the group of subjects it may require to display one record per event per subject (DEREFID should be populated in this case to show record relations), otherwise USUBJID variable will be missing.
- Device events may not be associated with the subject, in the case where an event occurred before the device was in contact with the subject, USUBJID will be missing.
- DEDECOD should be based on FDA's Device Problem Codes list (it can be found here: http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/PostmarketRequirements/ReportingAdverse Events/EventProblemCodes/ucm134761.htm).

DT – DEVICE TRACKING AND DISPOSITION

DT is an Events domain that represents tracking events for the given device and has one record per event per device/part of device/set of devices (it depends on level of granularity that described in DI (Device Identifiers) domain). Examples of events that fall into DT are: shipment, deployment, return, destruction, loss, etc.

- DT could be designed to account for the device at all times and track each party whoever was accountable for the device from the time it leaves the sponsor facility to its final state. Or it could display one disposition record for each device, representing the status of the device at the time of submission.
- Device Tracking domain does not have USUBJID so the primary identifier here is SPDEVID.
- DTPARTY specifies who has possession of the device after the action in DTTERM. If DTTERM is equal 'IMPLANTED' then DTPARTY='SUBJECT'.
- Relative study day variables are not included in the DT domain as dates are related to the device and not associated with the subject. However, they may be added per sponsor's requirements and derivation must followed by the SDTMIG rules.

DR – DEVICE-SUBJECT RELATIONSHIPS

DR is a Special-Purpose domain that was modeled to display the relationship between the subject and the device. DR should have a single consistent subject-device pair with one record per each pair. This permits other domains to determine the correct associations without having to store relationship data in every domain. No other information must be stored at this domain.

For more details and a full understanding of the structure and specifics of the device domains and their relationships with the other SDTM domains and each other, refer to Chapter 2 of the SDTM Implementation Guide for Medical Devices.

FIRST USE-CASE

STUDY OVERVIEW

The study is designed to evaluate the safety and efficacy of an investigational drug together with varying light dose activated by intra-urethral drug-activating device in male subjects. Subjects will receive a single dose of investigational drug with an activated delivery of light for a pre-programmed illumination time.

The study device is a customized catheter that consists of light-emitting diodes (LEDs). The drug activator is manufactured for single-use and will not function if an attempt is made to re-use it. The use of any device is to be recorded in an Accountability Log.

The light dose is delivered for a pre-programmed illumination time, commencing after intravenous administration of the investigational drug. In order to provide such treatment the drug activator is inserted into the urethra using a standard Foley catheterization procedures. The fixation of a catheter in an appropriate location is a required condition, so correct placement of the device is confirmed by pre-treatment using ultrasound. During treatment, the patient may not be moved, and should lie throughout the therapy.

Once the light dose is administered, the catheter will be removed and the single-use drug activator is to be considered to be bio hazardous waste and is to be disposed of according to the study site's standard procedure. If there are any device issues, they should be recorded and the device is to be returned to the manufacturer. Also other events such as dose interruptions or adverse events are to be collected as well.

SCHEME OF MAPPING DEVICE-SPECIFIC DATA
The major part of our devise study data was placed in the current SDTM device model. The device treatment we have studied requires six of the seven domains for a full description of the clinical data. However some device-related data fit to data models from the main SDTMIG and were linked to device domains using RELREC. The figure below shows how mapping of device data were modeled in this study.
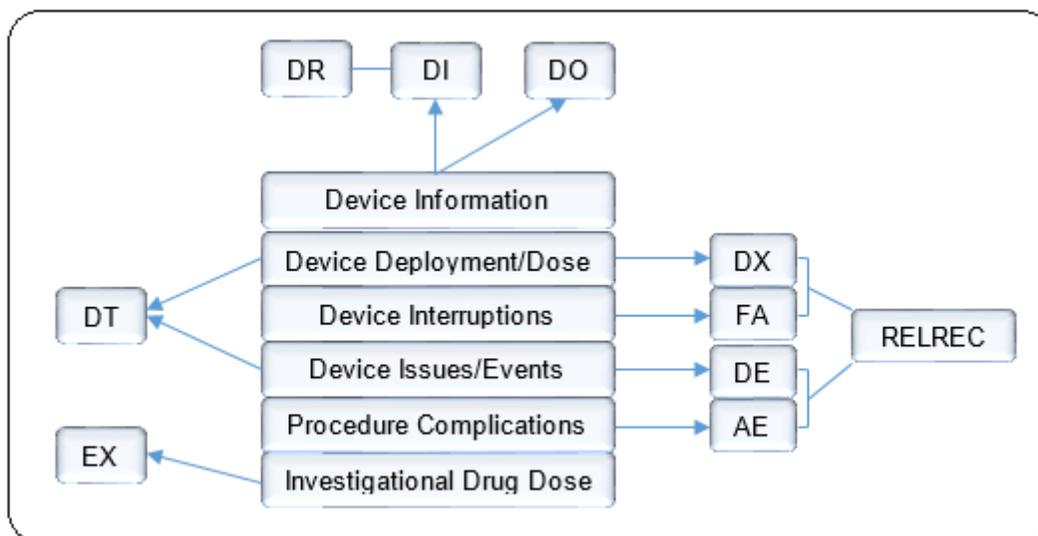
    Figure 1. Scheme of mapping device-specific data

Device identifiers and characteristics were easily captured in DI and DO domains. Since a combination of two kinds of treatments was studied, both DX and EX domains were created. EX contained information about investigational drug exposure that was injected intravenously while DX had information specifically about device exposure. During the device treatment due to various reasons, light dose exposure may be put on hold for a while and then restored. Details of such specific events are described in FA (Findings About) dataset and linked to DX in RELREC domain. Device problems were displayed in the DE domain, AE displayed any events that occurred to a subject that may or may not be related to device issues. Such relation is shown in RELREC as well. Device Tracking (DT) domain works well for the accountability of our study-related devices. On the other hand DR keeps a record of the devices that are associated with a patient at any point during the study. As it was described above, correct placement of the device is confirmed by using ultrasound. Details of this procedure are stored in the PR (Procedure) domain. Since results of this procedure are not related specifically to a device, they are not reviewed in this article. The features of each domain for this study data modeling are discussed in the following subsections more detail.

WHAT DEVICE DATA WERE COLLECTED
In this study, device-related data were collected on three CRF pages - Drug Activator Use, Drug Activator Interruptions, and Device Clinical Incident Report. It is shown below how each field from those pages was annotated.

'Drug Activator Use' image below includes device-identification information such as pack ID, model and serial numbers that goes to DI domain. Another block of data is exposure-related data. There were separately collected date/time of device deployment and removal and date/time of device dose start and end. Deployment information goes to two domains: DX (to show details of device contact to the subject) and DT (to track a device transition to the next stage at the study). Collected volume of light dose goes to DXDOSE variable and the light dose unit pre-printed in the CRF is assigned to the DXDOSU variable.

DI - Device Identifiers   DT - Device Tracking and Disposition
DX - Device Exposure

Form: Drug Activator Use

Field	Mapping	
Device pack ID number:	SPDEVID	
	DIVAL where DIPARM=Pack Number	①
Model number	DIVAL where DIPARM=Model	②
Serial number	DIVAL where DIPARM=Serial Number	③
Drug activator insertion date/time	DXSTDTC where DXTRT=Drug Activator	
	DTSTDTC where DTTERM=DEPLOYED	④
Drug activator device activation date/time	DXSTDTC where DXTRT=Drug Activator Light	⑤
Light dose (J/cm)	DXDOSE	
	DXDOSU	⑥
Drug activation stop date/time	DXENDTC where DXTRT=Drug Activator Light	⑦
Drug activator device removal date/time	DXENDTC where DXTRT=Drug Activator	⑧

Figure 2. CRF page 1.

'Drug Activator Interruptions' figure, as its name implies, gives details such as reason, date/time of pausing and resumption of a light dose exposure. Since they are supplemental descriptors of the light dose treatment that cannot appear in the DX domain, they go to the FA (Findings About) domain.

FA - Findings About

Form: Drug Activator Interruptions   FAOBJ='DRUG ACTIVATOR INTERRUPTIONS'

Field	Mapping	
Date/time of pausing	FAORRES where FATESTCD='INTPUDTC'	①
Date/time of resumption	FAORRES where FATESTCD='INTREA'	②
Reason for pausing	FAORRES where FATESTCD='INTREDTC'	③

Figure 3. CRF page 2.

'Device Clinical Incident Report' figure below specifies details about device issues, further action with device and impact of this issue to a subject. To cover these data DE, SUPPDE and DT domains were used.

DE - Device Events
DT - Device Tracking and Disposition

Form: Device Clinical Incident Report

Date issue occurred — DTSTDTC where DTTERM='RETURNED TO MANUFACTURER' / DESTDTC — ①

Description of issue — DETERM — ②

Device pack ID number: — SPDEVID — ③

Will the device be disinfected and returned to manufacturer — DTTERM='RETURNED TO MANUFACTURER' if 'Yes' / SUPPDE.QVAL where SUPPDE.QNAM='DEVRTN' — Yes◯ No◯ ④

Was there an unexpected adverse reaction? — SUPPDE.QVAL where SUPPDE.QNAM='UNEXPAE' — Yes◯ No◯ ⑤

If yes, specify AE number — DESPID — ⑥

Figure 4. CRF page 3.

Another source of data that complemented the set of data from the CRF is the protocol, where descriptive characteristics of the device, exposure details such as frequency and location, etc. were found.

HOW DEVICE DATA WERE STANDARDIZED
From the represented data, it is apparent that most device-related information fits well within existing device domains, some data are appropriate for the main SDTM domain. Detailed review of each domain is given below.

Device Identifier Domain:
In the DI domain, type, manufacturer, model, serial number and pack number provide a natural key for the unique drug activator identifier. As it was an observed model, serial and pack numbers were provided by the CRF, while manufacturer and type of device were requested to add per the sponsor's decision. However, type of device was unknown at the moment of initial mapping for this study and was under process to get GMDN term. Hence, TYPE parameter was included to the domain but the value of it was filled by temporary term 'TBD'. Note, it couldn't be left as missing because DIVAL is a required variable and must be populated as well as DIPARMCD and DIPARM. Here, SPDEVID is based on pack number.

STUDYID	DOMAIN	SPDEVID	DISEQ	DIPARMCD	DIPARM	DIVAL
AB1001	DI	20000	1	MANUF	Manufacturer	Manufacturer
AB1001	DI	20000	2	MODEL	Model	ABC123
AB1001	DI	20000	3	PACK	Pack Number	20000
AB1001	DI	20000	4	SERIAL	Serial Number	A745631
AB1001	DI	20000	5	TYPE	Type of Device	TBD
AB1001	DI	20001	1	MANUF	Manufacturer	Manufacturer
AB1001	DI	20001	2	MODEL	Model	ABC123
AB1001	DI	20001	3	PACK	Pack Number	20001
AB1001	DI	20001	4	SERIAL	Serial Number	A852746
AB1001	DI	20001	5	TYPE	Type of Device	TBD

Table 1. Sample of the DI domain.

Device Properties Domain:

Device Properties (DO) contains the device structural and functional properties that are not required for identification in the study and which correlate to device effectiveness and safety at the end of the study. It has a relatively free format in comparison with other device domains and accept a wide variety of data.

In our case, it is known that diameter of array of device LED is 1.2 mm, the volume of balloon for fixation in the bladder could vary from 5 to 10 cc. The light-emitting area of the device is a "window" of 25 mm in length and light wavelength is 660 nm. All of these characteristics were important to include in the submission, therefore they were stored in DO domain. DOTESTCD is a topic variable that includes the shorten name of each property, meanwhile DOORRES/DOORRESU specify the value and unit of it.

STUDYID	DOMAIN	SPDEVID	DOSEQ	DOTESTCD	DOTEST	DOORRES	DOORRESU
AB1001	DO	20000	1	BALVOL	Balloon Volume	5-10	mL
AB1001	DO	20000	2	LEDDIA	LED Array Diameter	1.2	mm
AB1001	DO	20000	3	LEWINDOW	Light Emitting Window	25	mm
AB1001	DO	20000	4	WAVELEN	Light Wavelength	660	nm

Table 2. Sample of the DO domain.

Device Exposure Domain:

Most of the device treatment variables are mappable to the DX domain, with the exception of a few variables which are specific to this study and were mapped in the FA domain. The DX dataset captures information about two kinds of events for each subject: about deployment of the particular catheter and light treatment provided via that catheter. The names of them are mapped to DXTRT (Name of Device Exposure or Output) variable and can have values such as 'Drug Activator' and 'Drug Activator Light' respectively. DXDOSE and DXDOSU were populated for both records, where in the first case it indicates the amount of devices that were used (in our case, it will be '1' Unit all the time). In the second case, we have a description of the amount of light dose (the values of which were taken from raw data and units were pre-specified in the CRF). Since this procedure can be performed only once to a subject, DXDOSFRQ (Device Exposure Frequency per Interval) was set to 'ONCE' for both records. Per protocol, it is known the procedure was performed intraurethral and the light dose is delivered to the prostate gland, so DXROUTE (Route of Administration) and DXLOC (Location of Device Exposure) were mapped to 'URETHRAL' and 'PROSTATE GLAND' accordingly. DXSTDTC and DXENDTC have exact date and time of each intervention. Here we already have 2 primary identifiers – USUBJID and SPDEVID.

Row	DOMAIN	USUBJID	SPDEVID	DXSEQ	DXTRT	DXDOSE	DXDOSU	DXDOSFRQ
1	DX	AB1001-1011010	20306	1	Drug Activator	1	U	ONCE
2	DX	AB1001-1011010	20306	2	Drug Activator Light	75	J/cm	ONCE
3	DX	AB1001-1011011	20314	1	Drug Activator	1	U	ONCE
4	DX	AB1001-1011011	20314	2	Drug Activator Light	150	J/cm	ONCE

Row	DXROUTE	DXLOC	DXSTDTC	DXENDTC	DXSTDY	DXENDY
1	URETHRAL	PROSTATE GLAND	2016-02-18T10:05	2016-02-18T12:38	1	1
2	URETHRAL	PROSTATE GLAND	2016-02-18T10:36	2016-02-18T12:33	1	1
3	URETHRAL	PROSTATE GLAND	2016-03-04T09:04	2016-03-04T12:02	1	1
4	URETHRAL	PROSTATE GLAND	2016-03-04T09:39	2016-03-04T11:49	1	1

Table 3. Sample of the DX domain.

As was mentioned previously, the FA domain includes information about light dosing that supplements information collected in the DX domain. Like all findings domains FATESTCD and FATEST describe test name, the value of which is stored in FAORRES variable. FAOBJ and FACAT are used to specify the object and category of test. FAGRPID ties together a block of related records and was used for relationship creation in RELREC. For more details of mapping FA see SDTMIG v. 3.2.

Row	DOMAIN	USUBJID	FASEQ	FAGRPID	FATESTCD	FATEST	FAOBJ
1	FA	AB1001-1039005	4	INT_V3	INTPUDTC	Pausing Date/Time	DRUG ACTIVATOR INTERRUPTIONS
2	FA	AB1001-1039005	5	INT_V3	INTREA	Reason for Pausing	DRUG ACTIVATOR INTERRUPTIONS
3	FA	AB1001-1039005	6	INT_V3	INTREDTC	Resumption Date/Time	DRUG ACTIVATOR INTERRUPTIONS
4	FA	AB1001-1054006	3	INT_V3	INTPUDTC	Pausing Date/Time	DRUG ACTIVATOR INTERRUPTIONS
5	FA	AB1001-1054006	4	INT_V3	INTREA	Reason for Pausing	DRUG ACTIVATOR INTERRUPTIONS
6	FA	AB1001-1054006	5	INT_V3	INTREDTC	Resumption Date/Time	DRUG ACTIVATOR INTERRUPTIONS

Row	FACAT	FAORRES
1	INVESTIGATIONAL DRUG ADMINISTRATION	2015-05-08T10:18
2	INVESTIGATIONAL DRUG ADMINISTRATION	SEVERE DISCOMFORT OF THE BLADDER AND RECTUM.
3	INVESTIGATIONAL DRUG ADMINISTRATION	2015-05-08T10:24
4	INVESTIGATIONAL DRUG ADMINISTRATION	2016-03-28T15:22
5	INVESTIGATIONAL DRUG ADMINISTRATION	BOWEL MOVEMENT
6	INVESTIGATIONAL DRUG ADMINISTRATION	2016-03-28T15:35

Table 4. Sample of the FA domain that supplements DX.

Device Tracking and Disposition Domain:

The mapping for the DT domain is straightforward for this study. There are three main stages of a device – shipment to the site, deployment to the subject and, in case of issues, return to the manufacturer, and otherwise disposal according to the study site's standard procedure after full accountability. Disposal details were not provided so it was not tracked in the DT dataset. DTPARTY (Party Responsible for the Device) variable has no analogs in the main SDTMIG models and describes who is responsible for the device after an event occurs, described in DTTERM. So if it is shipment, then DTPARTY is equal 'SITE' and DTPARTYID equals the number of the site, if deployment then 'SUBJECT' and subject number, respectively. There was no need to populate DTCAT, however it was included in the dataset since it is an expected variable.

DOMAIN	SPDEVID	DTSEQ	DTTERM	DTDECOD	DTPARTY	DTPRTYID	DTCAT	DTSTDTC
DT	30252	1	SHIPPED	SHIPPED	SITE	104		
DT	30252	2	DEPLOYED	DEPLOYED	SUBJECT	1047016		2016-03-24
DT	30252	3	RETURNED TO MANUFACTURER	RETURNED TO MANUFACTURER	MANUFACTURER			2016-03-24
DT	30253	1	SHIPPED	SHIPPED	SITE	102		
DT	30253	2	DEPLOYED	DEPLOYED	SUBJECT	1029012		2015-09-14

Table 5. Sample of the DT domain.

Device Events Domain:

Various reasons may be captured on a device clinical incident report CRF page. The information collected may include the relation of the observation with any of the components of the device or placement procedure, the main device or other part of the device such as power controller or balloon. Verbatim text of an issue is recorded in a topic variable DETERM (Reported Term for Device Event). Decoded value of each event is placed in DEDECOD (Device Events Dictionary-Derived Term) and was based on the Device Problem Codes list. In the example below, the second record shows device event that happed prior to start of the procedure, so it wasn't associated with any subject and therefore USUBJID is missing as well as DESTDY (since Device Domains do not have reference start period variable for device like it is for subject in DM that could be used for derivation of study day). The record number four describes the case when an adverse event occurred to a subject during the treatment, as a result procedure was not finished and catheter was removed. This adverse event was recorded in the AE dataset, while DE keeps information about a fact of a clinical incidence event. Since this event is not related to performance of a device, it has no analogs in a Device Problem Codes list, so DEDECOD is 'NOT APPLICABLE' in this case. Other four records display device-related issues/events and were mapped straightforward. DESPID variable was used to give a link to the number of adverse events that were caused by a device issue or somehow related to it. This relationship is shown in the RELREC dataset.

Row	DOMAIN	USUBJID	SPDEVID	DESEQ	DESPID	DETERM
1	DE	AB1001-1016001	20002	1		THE DEVICE WAS FLASHING ERROR AND WOULDN'T RESTART.
2	DE		20228	1		STERILE PACKAGING BREACHED
3	DE	AB1001-1047016	30252	1		CATHETER DID NOT ROTATE BACK APPROPRIATELY
4	DE	AB1001-1013042	30267	1	2	SUBJECT EXPERIENCED PAIN FROM CATHETER AND WAS REMOVED EARLY
5	DE	AB1001-1013065	30297	1	1	COMPLICATION WITH PLACEMENT OF DEVICE
6	DE	AB1001-1066016	30312	1		THE PATIENT INFORMED STUDY COORDINATOR THAT HE HAD SHIFTED AND HIT THE DEVICE, WHEN CHECKED THE DEVICE WAS MOVED

Row	DEDECOD	DECAT	DESTDTC	DESTDY
1	COMPUTER SOFTWARE ISSUE	DEVICE CLINICAL INCIDENT REPORT	2015-01-06	1
2	DELIVERED AS UNSTERILE PRODUCT	DEVICE CLINICAL INCIDENT REPORT	2015-08-27	
3	DIFFICULT TO REMOVE	DEVICE CLINICAL INCIDENT REPORT	2016-03-24	1
4	NOT APPLICABLE	DEVICE CLINICAL INCIDENT REPORT	2015-10-21	2
5	DIFFICULT TO POSITION	DEVICE CLINICAL INCIDENT REPORT	2016-01-18	1
6	UNINTENDED MOVEMENT	DEVICE CLINICAL INCIDENT REPORT	2016-02-22	1

Table 6. Sample of the DE domain.

The RELREC dataset represents two kinds of relationships. It links adverse events that were caused by device issues and drug interruptions with light doses. In the first case it is a one-to-one relation hence sequence variables were used as IDVAR and IDVARVAL. In the second case, a single dose record in DX was linked to the group of records in FA. To implement this relation DXSEQ and FAGRPID were used as identifier variables. For more details of mapping RELREC refer to SDTMIG v. 3.2 (CDISC SDTM, 2013)

STUDYID	RDOMAIN	USUBJID	IDVAR	IDVARVAL	RELTYPE	RELID
AB1001	AE	AB1001-1013042	AESEQ	1		DEAE1
AB1001	DE	AB1001-1013042	DESEQ	1		DEAE1
AB1001	AE	AB1001-1013065	AESEQ	1		DEAE1
AB1001	DE	AB1001-1013065	DESEQ	1		DEAE1
AB1001	DX	AB1001-1039005	DXSEQ	2		DXFA1
AB1001	FA	AB1001-1039005	FAGRPID	INT_V3		DXFA1
AB1001	DX	AB1001-1054006	DXSEQ	2		DXFA1
AB1001	FA	AB1001-1054006	FAGRPID	INT_V3		DXFA1

Table 7. Sample of records relationship in the RELREC domain.

Device-Subject Relationships Domain:
The DR domain keeps track of all subjects and their devices. In this study one subject associated only with one drug activator – the simplest design of this domain. There are only four variables and all are required to be populated.

STUDYID	DOMAIN	USUBJID	SPDEVID
AB1001	DR	AB1001-1011010	20306
AB1001	DR	AB1001-1011011	20314

Table 8. Sample of the DR domain.

SECOND USE-CASE
The second study differs from any device-treatment study. The device here is not under the study, however it plays a significant role in the trial.

STUDY OVERVIEW

The objective of the study is evaluating the benefit of adding a mobile application and wearable activity monitor to the standard of care of knee, demonstrating the impact on increasing the mobility of knee and determining the percent of changing an amount of steps per day per patient. The monitor will record the daily steps for the patients and this data will be stored in the device. The evaluation will be provided via comparison results of two groups of subjects. First group will know the amount of steps per day and another one won't.

Each subject will be issued by wearable activity monitor and trial sponsored Smartphone with the mobile application downloaded on the mobile. The mobile application will obtain information from the wearable activity monitor and combine that activity data with outcomes including daily pain and mood assessments that should be reported by the subject on a daily basis. All educational instructions will be available for the subjects in mobile application as well. An application will retrieve the information from activity monitor until it's downloaded by the site. Subjects should wear this tracker all the time with the exception of charging, taking shower or any other contact with water.

If any issue occurs with any of the devices it should be reported immediately, and probably will be replaced. After several months of trial period the set of devices will be returned to the sponsor.

STUDY SPECIFIC

This study is unique in that it is unusual for medical sphere devices to be combined with a mobile phone and wearable activity monitor used here to obtain the data. Moreover the impact of usage of specific device application on the standard treatment is under the study. Despite the fact that this study is unique in the object of the trial (impact of using the latest technologies such as mobile application) it's needed to use standard developed earlier to capture the data. As a result some issues appeared. Per current mapping guidelines, the data will be tabulated in SDTM as follows.
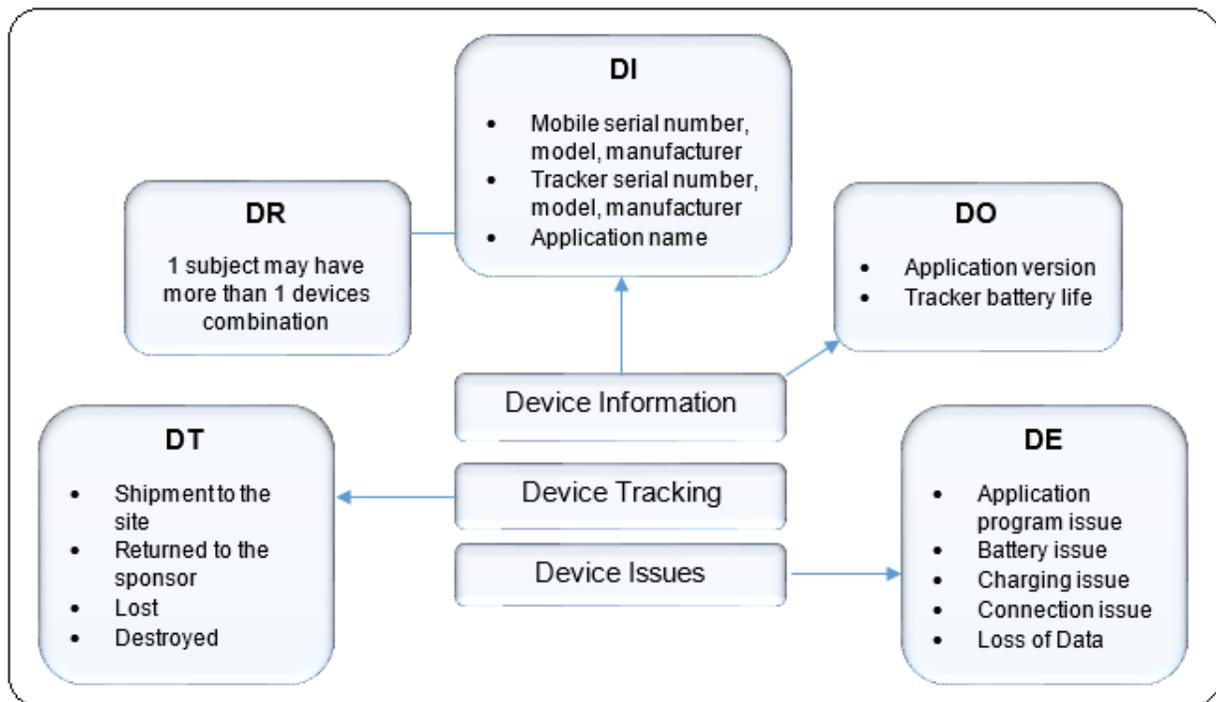

Figure 5. Scheme of mapping mobile device-specific data

Since the drug-treatment is not being studied and there is no device exposure, neither EX or DX are applicable. Also there are no settings that are specific for each subject, so DU domain is not created as well. However, the remaining five device domains are mapped. DI captures identifier information about all three elements (mobile, tracker and mobile application). SPDEVID represents a unique key created manually to display combination of the mobile and wearable activity monitor identifiers. DO stores other characteristics such as application version and tracker battery life.

Device events could be very different starting from device-handing issues to technical issues or software performance. Such events are stored in the DE domain. DT shows disposition events such as shipment, return, lost or destruction. In

DR, there may be one or more devices for one subject during the whole study in case of any serious issues and device replacement afterwards. Collected pain and mood assessments' responses by the mobile application will be mapped to the QS dataset. No AEs were related to device malfunctions in this study. If that had occurred, it would have been an issue that no data link was collected (like an AE number), so RELREC cannot be created.

CHALLENGES

Since these domains were designed a while ago, due to lack of experience and device specific, there is a possibility of mapping device data not always accurate. Although most of the device data fit well within the device domains, there are still some challenges in the standardization process of such data:

- Often there is an issue with modeling of data collection - device identifiers are provided not everywhere in raw data where needed or in not appropriate way that causes problems with creating SPDEVID and relationship between subject and device.
- DIPARMCD=TYPE is a required parameter in DI domain, but access to Global Medical Device Nomenclature (GMDN) is not freely available.
- It's unclear what DIPARMCDs should be created. There is a need to involve the sponsor participation to close this issue.
- Device Problem Codes list is required to be used in creation of the DEDECOD variable – it's not obvious how to decode DETERM values.
- There are studies where subjects didn't have device exposure nor drug-treatment, so they had no EX or DX domains that lead to OpenCDISC error.
- Not all device data fit Device Domains. As a result, there is a need to find the best place for these data in other SDTMIG models.

CONCLUSION

There are more kinds of devices are getting increasingly used in medical world as well as in our lives. The devices may differ substantially from each other in their design, mode of action, material composition, and location of administration, planned duration in the body and delivery/surgical procedures. The data from the study of these devices embody, in a large part, the spectrum of clinical data produced by devices. Standardization of collected data for medical device trials is important for efficient data. For this purpose seven Device Domains were designed. They cover different information such as identifiers, characteristics and settings used for each device in the study, details of device deployment or drug exposure and the recording of disposition events or other device-related events such as malfunction.

Through this paper we reviewed the specifics of Device Domains standard and discussed two study cases where medical devices played different roles in the trial. In the first case, the combination of device and treatment is under the study and, in the other case, the objective of a trial is to investigate the influence of device use on a standard treatment, but the device itself is not under the study. We see that Device Domains can be applied for various study designs.

We found out that the SDTM Device Domain model is robust and very useful to those working in the device area. However there are still challenges with mapping such data.

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CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author at

     Oksana Voevutska
     Chiltern
     51B Bohdana Khmelnytskogo str.
     Kyiv/ 01030, Ukraine
     Work Phone: +380 44 482 1042
     Mobile: +380 50 608 2232
     Fax: +380 44 482 3248
     Email: Oksana.Voevutska@Chiltern.com

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