

1. Analysis Normal Form Statements

The goals of Analysis Normal Form (ANF) are to enable analysts to understand the data and how it is stored in lieu of having to teach them about the thousands of ways data can be entered (i.e., CIF), and to ensure the data we need expressed can be expressed in an operable, scalable way. The more normalized the data, the simpler it is to analyze reducing the likelihood of analysis errors. The probability of patient safety risks increases greatly without the ANF. Examples of problems that can occur are:

- An inability to determine that two clinical statements are equivalent
 - Taking two 250 mg acetaminophen tablets is the same as taking one 500 mg tablet but the analyst only queries for one of the statements, not both.
 - Presence of dot blot hemorrhage and 2 dot blot hemorrhages observed are equal in regard to presence and absence but the analyst queries only for presence vs. a quantitative finding of dot blot hemorrhages.
- An inability to express something that is clinically significant
 - We may not be able to express chest pain on inspiration, which can be a sign of pleurisy. The ability to differentiate cardiac chest pain from other types of chest pain is clinically important. An example of something that needs to be represented is chest pain that worsens when you breathe, cough, or sneeze.
- An error is made in recording or in querying a repository for clinical statements
 - On October 1, 2016, a provider enters a medication order for acetaminophen 250 mg for a patient to take 1 tablet twice daily for 2 days starting October 1, 2016
 - CIF: Provider enters the medication order
 - ANF: Analyst creates a CDS rule to identify all patients ordered acetaminophen during the period September 1 – December 31, 2016. However, while the analyst creates a query to search for a clinical statement (i.e., Request) where acetaminophen was the direct substance and was ordered during the period September 1 – December 31, 2016, the analyst did not include a Request topic of “Administration of drug or medication PO BID for pain.” Thus, the medication order would not be included in the query results.

A. ANF Clinical Statements Represent the Minimum Disjoint Set: ANF clinical statements represent the minimum disjoint set of statement topic, result, and details and may not be further specified.

B. ANF Classes Cleanly Separate Concerns: ANF classes must cleanly separate the concerns of concept definition and the concerns of domain models.

- **NOTE:** Need to define the domain models thoroughly here. The strawman description is that domain models use concept definitions as a building block to define non-defining relationships or associations between concepts. The domain model represents cardinality, optionality, and other constraints.
- **Example:** Laterality should be a concern of either the concept definition or the domain model, but not both. We can relax this principle for the Clinical Input Form (CIF) but for ANF we need a clean and invariant separation of concerns.
- **NOTE:** Need to determine better names for “concept definition” and “domain models.”

1.1. Clinical Statements

A clinical statement represents an entry in the patient record that documents clinical information:

- about a subject of information, such as a patient or a relative of the patient
- that is asserted and recorded by a particular source, such as a clinician
- in a structured/computable manner

Clinicians typically enter information into an EHR in a certain manner: the clinical input form (CIF). The CIF is not a literal “form”. It refers to the manner in which information is presented to the clinicians and how they enter the data, e.g.

- by constraining the information to allow only certain values to be entered, such as through a drop-down list or radio button
- breaking up large chunks of related information into smaller parts like in medication orders

1.1.1. Principles

- **Proposed Principle 1:** There are two types of clinical statements:
 - **Performance of action**, which include passive observation of a phenomenon related to patients and their health status or family history, and active interventions, such as providing education or administering medications.
 - **Request for action**, which may include passive observation of a phenomenon related to patients and their health status or family history, and active interventions, such as providing education or administering medications.
- **Proposed Principle 2:** Both types of clinical statements consist of topics and circumstances
- **Proposed Principle 3:** Each clinical statement can have only one topic and multiple circumstances

1.2. Clinical Statement Decision Tree

1.3. Clinical Statement Components

Table 1.1. Example Clinical Statement Model

Clinical Statement																								
Narrative:	Ibuprofen 400 mg tablet oral every 6 hours as needed for back pain; may increase dose frequency to one tablet every 4 hours																							
Statement type:	<i>[Request]</i>																							
Subject of info:	<i>[410604004 /Subject of record]</i>																							
Mode:	<i>[Template]</i>																							
Authors:	<i>[223366009/Healthcare professional]</i>																							
Action topic:	<i>[Procedure]-</i> <i>#[260686004/Method]#[129445006/Administration - action]</i> <i>#[363701004/Direct substance]#[197805/Ibuprofen 400 MG Oral Tablet]</i> <i>#[410675002/Route of administration]#[260548002/Oral]</i>																							
Circumstance:	<table> <tr> <th colspan="2">Request Circumstance</th></tr> <tr> <td colspan="2">Timing: <i>[2007-04-05T14:30Z , 2007-04-05T15:00Z]±P5M [ISO 8601]</i></td></tr> <tr> <td colspan="2">Purposes: <i>[161891005 /Backache (finding)]</i></td></tr> <tr> <td colspan="2">Triggers: <i>Ø associate statement backache present</i></td></tr> <tr> <td colspan="2">Participants: <i>[410604004 /Subject of record]</i></td></tr> <tr> <td colspan="2">Priority: <i>[50811001 /Routine (qualifier value)]</i></td></tr> <tr> <td rowspan="4">Repetitions:</td><td>Repetition</td></tr> <tr> <td>Start: Anytime, as needed</td></tr> <tr> <td>Duration: 24 hours</td></tr> <tr> <td>Frequency: 4-6 hours</td></tr> <tr> <td colspan="2">Maximum: <i>Ø</i></td></tr> <tr> <td colspan="2">Duration: <i>Ø</i></td></tr> <tr> <td colspan="2">Result: 4</td></tr> </table>	Request Circumstance		Timing: <i>[2007-04-05T14:30Z , 2007-04-05T15:00Z]±P5M [ISO 8601]</i>		Purposes: <i>[161891005 /Backache (finding)]</i>		Triggers: <i>Ø associate statement backache present</i>		Participants: <i>[410604004 /Subject of record]</i>		Priority: <i>[50811001 /Routine (qualifier value)]</i>		Repetitions:	Repetition	Start: Anytime, as needed	Duration: 24 hours	Frequency: 4-6 hours	Maximum: <i>Ø</i>		Duration: <i>Ø</i>		Result: 4	
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	Frequency: 4-6 hours																							
Maximum: <i>Ø</i>																								
Duration: <i>Ø</i>																								
Result: 4																								
Associations:	<i>Ø</i>																							
Statement time:	<i>[2007-04-05T14:30Z , 2007-04-05T15:00Z]±P5M [ISO 8601]</i>																							
Stamp coordinate:	<i>[SOLOR Module], [Release Path], 2007-04-05T14:30Z</i>																							
Statement id:	a3b46565-f8cd-4354-b4b6-3dff42d33496																							
Subject of record ID:	<i>Ø</i>																							

1.3.1. Statement Identifier

The UUID is the means by which all clinical statements requiring unique identifiers are identified.

1.3.2. Mode

Needs clarification

1.3.3. STAMP coordinate

[SOLOR Module], [Release Path], [Date/Time in ISO 8601 Standard Format]

1.3.4. Narrative

The clinical statement as a whole, e.g. “Ibuprofen 400 mg tablet oral every 6 hours as needed for back pain; may increase dose frequency to one tablet every 4 hours”

1.3.5. Statement time

Time when the statement was documented in ISO 8601 Date/Time Standard Format

1.3.6. Subject of Record Identifier

UUID identifier for the subject of record.

1.3.7. Statement Authors

Figure 1.1. Participant

Participant	
getParticipantRole()	LogicalExpression
getParticipantId()	Optional<UUID>

Optional list of participants, e.g. “Healthcare professional”, “Nurse”

1.3.8. Participant Role

Optional role for participants, e.g. “Requester”.

1.3.9. Participant Identifier

Optional. UUID Identifier for the participant.

1.3.10. Subject of Information

Subject of Information is used to express **WHO** the clinical statement is about, e.g. the patient or a family member.

1.3.11. Statement Type

Statement Type distinguishes between a performance (“performed”) and a request (“requested”). Performances may be observational performances, e.g. the observation of a clinical finding or disorder being present or absent. They can also be statements of a procedure or intervention, which has been performed on the subject of record in the past, e.g. “12-lead electrocardiogram”. Performances can – but do not have to – include quantitative or qualitative results, e.g. “3 dot blot hemorrhages” or “Hepatitis A antibody positive”.

1.3.12. Topic

The topic is the expression of **WHAT** is being requested or what was performed. For both clinical statement types (request or performance) a pre-coordinated or post-coordinated SOLOR “procedure” concept as a logical expression is required to sufficiently capture the action, which is either requested or performed.

Requests for actions are always procedures or interventions:

- Stress echocardiogram
- Administration of Aspirin 81 mg oral tablet
- Systolic blood pressure measurement

Performances of actions can be performed procedures like the examples above. They can also be observational procedures, describing the absence or presence of clinical findings or disorders. In these cases, the observation action of the clinical findings and disorders is performed:

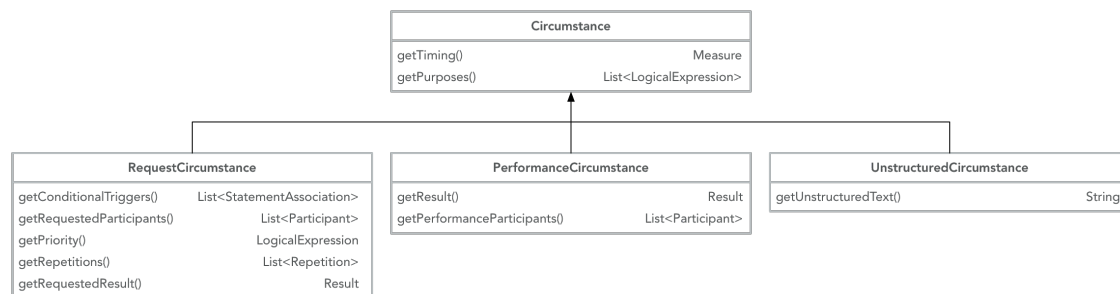
- Observation of congestive heart failure
- Observation of history of malignant neoplasm of bone
- Observation of numbness of left arm
- Observation of history of cognitive behavioral therapy

The topic is the central component of clinical statements.

- The topic defines the action being performed or requested.
- The topic has to be able to exist on its own yet still retain original intent and clarity of meaning.
- The topic includes what is being requested, measured or observed.

1.3.13. Circumstance

Figure 1.2. Circumstance, including request, performance, and unstructured subtypes



Circumstances can describe **HOW**, **WHY** and **WHEN** a requested or performed action will be or was carried out. Requests and performances have some shared circumstances:

- Timing: **WHEN** a requested action should be performed or **WHEN** an observed finding or disorder was present or absent.
 - Examples:
 - Cardiology Consult in 2 weeks
 - Breast cancer screening 3 months ago
 - Purpose: **WHY** an action was requested or performed
 - Examples:
 - Echocardiogram to evaluate arrhythmia
 - Education about allergens for anaphylaxis management
- Other circumstances are specific to requests or performances.

1.3.13.1. Request Circumstance

Figure 1.3. Request circumstance

RequestCircumstance	
getConditionalTriggers()	List<StatementAssociation>
getRequestedParticipants()	List<Participant>
getPriority()	LogicalExpression
getRepetitions()	List<Repetition>
getRequestedResult()	Result

Request circumstance further specify **HOW** a requested action is to be performed, e.g. how often, how long or with which category of priority.

1.3.13.1.1. Conditional Triggers

Needs clarification

1.3.13.1.2. Requested Participants

Requested participants can be either specific persons or roles who perform an action, assist in performing an action or are targets of an action. **Examples:**

- Cardiology consultation with Chief Cardiologist
- Smoking cessation education with patient and patient's spouse

1.3.13.1.3. Priority

Expresses the priority with which a requested action has to be carried out, e.g. "routine" or "stat".

1.3.13.1.4. Repetitions

Figure 1.4. Repetition

Repetition	
getPeriodStart()	Measure
getPeriodDuration()	Measure
getEventFrequency()	Measure
getEventMaximum()	Measure
getEventDuration()	Measure

If an action is requested for more than a single occurrence, the repetition allows to specify:

- When the repeated action should begin (PeriodStart), e.g. NOW
- How long the repetitions should persist (PeriodDuration), e.g. for 3 weeks
- How often the action should occur (EventFrequency), e.g. 3 times per week
- Maximal number of occurrences (EventMaximum), e.g. 10 times
- How long every occurrence should last (EventDuration), e.g. for 5 minutes

1.3.13.1.5. Requested Result

A patient goal to be achieved or a request for action further specified or quantified.

Examples:

Narrative: Administration of Metoprolol tartrate 50 mg oral daily 2 times to lower systolic blood pressure to <130 mmHg

Narrative: Diltiazem 30 mg, one tablet oral daily 4 times

1.3.13.2. Performance Circumstance

Figure 1.5. Performance

PerformanceCircumstance	
getResult()	Result
getPerformanceParticipants()	List<Participant>

1.3.13.2.1. Result

Result of diagnostic or observational procedures

Examples:

Narrative: Systolic blood pressure 120 mmHg

Narrative: Body weight 165 pounds

1.3.13.2.2. Performance Participants

Participants in performing the action, e.g. technician, nurse

1.3.13.3. Unstructured Circumstance

1.3.13.3.1. Unstructured Text

1.3.14. Statement Associations

Figure 1.6. Statement Association

StatementAssociation	
getAssociationSemantic()	LogicalExpression
getAssociatedStatementId()	UUID

1.3.14.1. Association Semantic

1.3.14.2. Associated Statement ID

1.4. ANF Modeling Guidelines

1.4.1. Introduction

The purpose of this section is to describe editorial guidelines for modeling terminology artifacts used to express the content of Knowledge Artifacts (KNARTs), e.g. Documentation Templates, Consultation Requests and Order Sets, in a computer readable form. This section will attempt to outline background information related to terminology models for KNARTs as well as provide modeling guidelines necessary for encoding clinical statements. This is a working draft document and subject to change.

1.4.2. Background

Knowledge Artifacts are computable representations of Clinical Decision Support (CDS) knowledge. They consist of clinical statements and orders within a framework of structured clinical documentation. Terminology artifacts in this context are developed to represent the clinical assertions and their values and are composed of standard clinical terminologies. The prioritized terminologies for the representation are SOLOR terminologies (SNOMED CT, LOINC and RxNorm) in alignment with the recommendations and requirements by the Office of the National Coordinator for Health Information Technology (ONC) and the VA – Department of Defense (DoD) Interagency Program Office (IPO). This section will describe each of the terminology artifact components and provide guidelines for modeling the values of these components. These guidelines are under development and remain subject to change as a result of the need to develop a consistent terminology model and coding strategy.

1.4.3. KNART Types and Structure

Four types of KNARTs have been developed for the VA KNART Project:

- Documentation Template

- Order Set
- Consultation Request
- Event Condition Action (ECA) Rule

The clinical content of each KNART is specific to clinical domains and prioritized areas of focus within the domains.

Example:

- Domain: Cardiology includes
 - Chest Pain/Coronary Artery Disease
 - Atrial Fibrillation
 - VTE Prophylaxis

The “Composite KNART” for each of the clinical focus areas above is comprised of at least the documentation template, the order set and the consultation request. Many, but not all Composite KNARTs also have ECA rules.

1.4.4. Documentation Templates

Documentation templates are created to document clinical information about patients, such as History and Physical, and treatment provided in the past as well as past results from lab tests, imaging procedures and other diagnostic studies. In many cases, the clinical information captured here is associated with either a defined timeframe, e.g. diagnostic studies within the past year, or a more undefined timeframe, e.g. history of prior cardiac evaluations.

1.4.5. Order Sets

Order sets are used to document requests for diagnostic or therapeutic procedures for the patient. As such, these requested procedures will occur at a future time.

Common categories for the ordered procedures include:

- Administration/Prescription/Dispensing of medications
- Imaging procedures
- Electrophysiology procedures
- Therapies
- Laboratory procedures
- Education procedures

The requested procedures may also include additional information, e.g.

- Timing, e.g. when the action should be performed
- Specific instructions for the procedures
- Priorities

- Frequencies

1.4.6. Consultation Request

Consult Requests are often relatively short KNARTs, which include

- Reason for Consult, e.g. chest pain
- Consult Specialty, e.g. cardiology
- Priority, e.g. Routine
- Referring Physician
- Referring Physician Contact Information

1.4.7. ECA Rule

ECA Rules are used in Clinical Decision Support to trigger a defined action after a distinct event occurred. Example: Notify clinician if laboratory test result with “abnormal” flag has been received.

1.5. Terminology Service Request (TSR)

The clinical statements within a KNART, which have to be captured by standard terminologies using a number of codes from e.g., SNOMED CT, RxNorm or LOINC are represented in Terminology Service Requests (TSRs). One TSR contains a variable number of Instance Requests (IRs), each of which represents a single clinical statement. The format used to assemble and encode a TSR is a MS Excel spreadsheet template.

The example below shows orders as they potentially appear in a KNART:

Figure 1.7. Order Example (Cardiology Order Set)

[Section Selection Behavior: More than one may be selected. Optional]

- ☐ resting 12-lead electrocardiogram to evaluate chest pain (routine)
- ☐ x-ray chest to evaluate chest pain(routine)

The order from the KNART above appears in the TSR as an Instance Request:

Figure 1.8. Order Set Instance Request in TSR Template

	A	B	D
Instance Request	Textual Representation		resting 12-lead electrocardiogram to evaluate chest pain (routine)
1			

1.6. Terminology Modeling Guidelines

The request and performance clinical statement types as described in the ANF Model and Guidelines section of this document have a number of shared components. Other components are specific to the statement type. The following sections will define the terminology modeling principles for each component in detail. The choice of logical expressions to use for each component is not always straightforward, and the terms in the SOLOR terminologies are not always unambiguous in their semantic meaning. In situations

where there may be more than one choice or more than one way to code a clinical statement or one of its components, it is important to ensure consistency of modeling approaches across clinical domains and clinical statements.

The following chapters describe the terminology modeling guidelines based on the current ANF model and the current TSR template fields. The TSR template has two tabs for Instance Requests (IRs). One tab “request” contains IRs for requested actions, one tab “performance” contains IRs for performed actions. Both tabs have a number of fields in common. Some fields are different and unique to the specific type of IR.

1.6.1. Instance Request (Request and Performance)

Represents the clinical statement to be modeled.

1.6.2. statementID (Request and Performance)

Not for modeling. ID will be assigned by KNART developers.

1.6.3. statementType (Request and Performance)

Format: Logical Expression

Terminology: SNOMED CT

Coding: Either “385644000 |Requested (qualifier value)|” for request IRs or “398166005 |Performed (qualifier value)|” for performance IRs

1.6.4. METADATA: model fit (Request and Performance)

Currently not in use.

1.6.5. METADATA: model fit comments (Request and Performance)

Currently not in use.

1.6.6. subjectOfInformation (Request and Performance)

Format: Logical Expression

Terminology: SNOMED CT

Subject of information is in most cases the patient: 410604004 |Subject of record (person)|. However, if the information is about, e.g. the patient’s mother or another family member, it is not the patient.

Examples: 72705000 |Mother (person)|, 303071001 |Person in the family (person)|

1.6.7. topic (Request and Performance)

The topic field represents what is being requested or has been performed. Although both request and performance IRs share this field, the handling is different to a certain extent.

Format: Logical Expression

Terminology: SOLOR

The actual coding of the topic depends on the procedure requested or performed. Generally, pre-coordinated or post-coordinated expressions are used. Post-coordinated expressions can be “hybrids” and include terms from different terminology standards (See Medication example below).

The pre-coordinated or post-coordinated expressions in the topic field are ALWAYS procedures.

1.6.8. Medication (Request and Performance)

Currently, medications are interpreted as the administration of a medication, not the prescription. The administration can be either requested or documented as being done. Therefore, all medications are post-coordinated based on the SCT “416118004 |Administration (procedure)” concept. To capture the drug itself, RxNorm codes are used. The specific RxNorm codes depend on the specificity of the IR. Attribute/value pairs needed to fully post-coordinate the expression are SCT concepts.

Example Instance Request:

Naproxen sodium 550 mg tablet oral every 12 hours as needed for back pain 100 tablets 2 refills

Post-coordinated expression with *conceptual graph*¹ syntax:

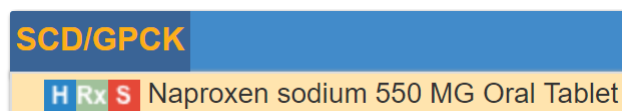
```
[416118004 |Administration (procedure)]
->(260686004 |Method (attribute))->[129445006 |Administration - action (qualifier value)]
->(363701004 |Direct substance (attribute))->[Rx;849431 Naproxen sodium 550 MG Oral Tablet]
->(410675002 |Route of administration (attribute))->[260548002 |Oral (qualifier value)]
```

Coding guidelines for dosage, frequency, total number of tablets and refills etc. will be discussed in later sections. This detailed information is typically only included in medication requests, while performances typically only document that the medication has been taken as a “History of....” Statement.

Notes:

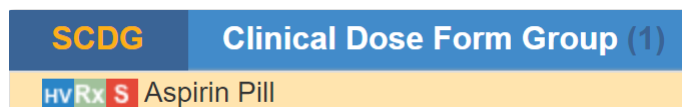
1. The IR is specific enough regarding strength and dose form. Therefore, the RxNorm SCD code can be applied

Figure 1.9. RxNorm SCD Code



2. Other medication requests or performances are less specific. The IR might only state “Aspirin tablet”. In these cases, the RxNorm SCDG codes are used:

Figure 1.10. RxNorm SCDG Code



3. If the IR states a class of drugs, e.g. “Glucocorticoids”, the coding approach is cascaded:

¹ https://en.wikipedia.org/wiki/Conceptual_graph#Graph-based_knowledge_representation_and_reasoning_model

- First choice: SNOMED CT concept from the “product” hierarchy
- Second choice: NDF-RT code
- 4. “Route of administration - oral” is included in the post-coordinated expression. Although the RxNorm code includes “oral tablet” it does not sufficiently capture that this tablet is administered orally.
- 5. The “Rx;” prefix for the RxNorm code in the post-coordinated expression indicated the terminology standard. Current modeling guideline: All concepts are SNOMED CT concepts, unless otherwise stated.
- 6. The IR example states: Naproxen sodium 550 mg tablet oral every 12 hours as needed for back pain 100 tablets 2 refills. Although it is not explicitly stated, the currently agreed upon policy is to interpret this as: 1 tablet at a time.

1.6.9. Non-Medication Procedures (Request and Performance)

Other procedures in the “topic” field, e.g. diagnostic procedures, therapeutic procedures, consults or observational procedures are coded as pre-coordinated or post-coordinated expressions using SNOMED CT concepts.

For IRs (either request or performance) a “simple” procedure, e.g. “Echocardiogram”, entering the procedure code “40701008 |Echocardiography (procedure)|” in the topic field sufficiently captures the IR.

For more complex IRs, particularly where body sites or lateralities are included, some principles to ensure consistency in the modeling must be applied.

1. Always post-coordinate when “laterality” is involved

- There are many pre-coordinated SCT concepts, which include body site and laterality, e.g. “1451000087102 |Computed tomography of right lower limb (procedure)|”, but not all body sites in SCT are lateralized.
- To achieve consistency in the modeling approach, instead of using the pre-coordinated concept above, post-coordinate the body structure and the laterality as shown below:

[241570001 |Computed tomography of lower limb (procedure)]-

->(363704007 |Procedure site (attribute))

->[61685007 |Lower limb structure (body structure)]- ->(272741003 |Laterality (attribute))->[24028007 |Right (qualifier value)];

2. For IRs without involving laterality, the choice for coding the topic is cascaded:

- a. 1st choice: existing pre-coordinated concept
- b. 2nd choice: post-coordinated expression, using existing concepts within the constraints of the concept model
- c. 3rd choice: post-coordinated expression, using existing concepts outside the constraints of the concept model, after discussion and approval
- d. 4th choice: new SCT HSPC SOLOR extension pre-coordinated concept, after discussion and approval; use generated UUID until the concept is created

1.6.10. Observational Procedures (Performance)

In the “performance” tab of TSRs, many of the IRs pertain to the documentation of findings or disorders. These are “observational” procedures, often documented within “history and physical” sections of documentation templates, which describe the presence or absence of a finding or disorder.

This category of IRs is always captured as a post-coordinated expression in the topic field.

Example IR: Weakness of neck

Post-coordination:

```
[a997cc03-3e99-40eb-833a-6374c7750a3a |Observation procedure (procedure)]-
->(363702006 |Has focus (attribute))->[249931001 |Weakness of neck (finding)]
```

Example IR: Right arm pain

Post-coordination:

```
[a997cc03-3e99-40eb-833a-6374c7750a3a |Observation procedure (procedure)]-
->(363702006 |Has focus (attribute))->[22253000 |Pain (finding)]-
->(363698007 |Finding site (attribute))->[53120007 |Upper limb structure (body structure)]-
->(272741003 |Laterality (attribute))->[24028007 |Right (qualifier value)];
```

1.6.11. Unstructured (Request and Performance)

Format: Plain text

Currently used to capture textual information for which there is no model at this time.

1.6.12. statementAssociation.semantic (Request and Performance)

Format: Logical Expression

Terminology: TBD Currently not in use

1.6.13. statementAssociation.statementId (Request and Performance)

For use by KNART developers.

1.6.14. Timing (Request and Performance)

The “timing” circumstance has six components:

1. timing.lowerBound

Format: Number (“float”)

2. timing.upperBound

Format: Number (“float”)

3. timing.includeLowerBound

Format: TRUE or FALSE (“Boolean”)

4. timing.includeUpperBound

Format: TRUE or FALSE (“Boolean”)

5. timing.resolution (optional)

Format: Number (“float”)

6. timing.measureSemantic

Format: ISO 8601 Date/Time Format

Timing is used to capture a time or time range for

- Requests for action at a future time
- Performance of action, which has taken place in the past (including “History of X....”)

The timing is always expressed as a time or time range relative to the statement time, using the ISO 8601 Date/Time Standard format².

If the actual time or time range is not specified in the IR, the following expressions are used:

- ISO 8601 prior to statement time
- ISO 8601 following statement time

If the time or time range is specified in the IR, the expression also follows the ISO 8601 Standard, using the appropriate prefixes for periods of time:

- P for period
- M for months
- W for weeks
- Y for years

Using additional fields in the timing circumstance, depends upon the degree of specificity within the IR.

Example (unspecific): History of breast cancer

Table 1.2. Timing - unspecific

timing.lowerBound	1
timing.upperBound	inf
timing.includeLowerBound	TRUE

² https://en.wikipedia.org/wiki/ISO_8601

timing.includeUpperBound	FALSE
timing.resolution	
timing.measureSemantic	ISO 8601 prior to statement time

The IR implies:

- Breast cancer was present in the patient's history = timing.lowerBound = 1
- No time range specified = timing.upperBound = inf (infinite)
- There was at least 1 instance = timing.includeLowerBound = TRUE
- "upper bound" is infinite = timing.includeUpperBound = FALSE ("inf" is never included!)
- IR does not specify units of time, e.g. years, months = timing.resolution = blank

Note: The expression of "present" could also be correctly indicated using

timing.lowerBound = 0

timing.includeLowerBound = FALSE

Not including "0" also expresses that there has to be at least "1". However, it is the current agreed policy to use the "1/TRUE" option.

Example (specific range): Anticonvulsant therapy greater than 2 years

Table 1.3. Timing - specific range

timing.lowerBound	24M
timing.upperBound	inf
timing.includeLowerBound	FALSE
timing.includeUpperBound	FALSE
timing.resolution	1M
timing.measureSemantic	ISO 8601 prior to statement time

The IR expresses:

- Anticonvulsant therapy for more than 2 years (24 months) was present in the patient's history = timing.lowerBound = 24M
- No upper time limit specified = timing.upperBound = inf (infinite)
- There was anticonvulsant therapy for more than 24 months = timing.includeUpperBound = FALSE
- Timing.measureSemantic = ISO 8601 prior to statement time
- timing.resolution field:
 - This field is optional, but if a time or time range is specified, the resolution has to be specified.
 - The use depends on the desired granularity of the time increments

- Some of the reasoning about how to use these fields depends on the clinical relevance.

Example (specific date): Completed Appointed on March 12 2018 with Cardiology

Table 1.4. Timing - specific date

timing.lowerBound	2018-03-19T12:01
timing.upperBound	2018-03-19T23:59
timing.includeLowerBound	TRUE
timing.includeUpperBound	TRUE
timing.resolution	
timing.measureSemantic	ISO 8601

Note: ISO 8601 uses the 24 hour standard for time of day.

1.6.15. Purpose (Request and Performance)

Format: Logical Expression

Terminology: SNOMED CT

The “purpose” field is used to capture WHY a procedure was requested or performed in a post-coordinated expression, based on two possible procedures:

Evaluation procedure: 386053000 |Evaluation procedure (procedure)|

Therapeutic procedure: 277132007 |Therapeutic procedure (procedure)|

The procedure is refined by post-coordinating with a “363702006 |Has focus (attribute) |” attribute and identifying a finding/disorder or procedure concept as the value for the attribute.

Example IR: Resting 12-lead electrocardiogram to evaluate for arrhythmia

```
[386053000 |Evaluation procedure (procedure)]
->(363702006 |Has focus (attribute))->[ 698247007 |Cardiac arrhythmia (disorder)]
```

Example IR: Naproxen sodium 550 mg tablet oral every 12 hours as needed for back pain 100 tablets 2 refills

```
[277132007 |Therapeutic procedure (procedure)]
->(363702006 |Has focus (attribute))->[161891005 |Backache (finding)]
```

IRs can have more than one purpose.

1.6.16. requestedResult (Request and Performance)

The “requestedResult” circumstance has eight components:

1. requestedResult.lowerBound

Format: Number (“float”)

2. requestedResult.upperBound

Format: Number (“float”)

3. requestedResult.includeLowerBound

Format: TRUE or FALSE (“Boolean”)

4. requestedResult.includeUpperBound

Format: TRUE or FALSE (“Boolean”)

5. requestedResult.resolution (optional)

Format: Number (“float”)

6. requestedResult.measureSemantic

Format: Logical Expression

7. requestedResult.healthRisk

Format: Logical Expression

8. requestedResult.status

Format: Logical Expression

The “requestedResult” fields 1 – 6 above are used to capture IRs, which

- enumerate what is being requested, e.g. Administration of a medication **1 tablet at a time**
- specify the intended outcome of an action, e.g. Administration of Metoprolol to **achieve systolic BP < 130 mmHg**

Example IR: Metoprolol tartrate 50 mg tablet oral daily 2 times

Table 1.5. requestedResult -Example 1

requestedResult.lowerBound	1
requestedResult.upperBound	1
requestedResult.includeLowerBound	TRUE
requestedResult.includeUpperBound	TRUE
requestedResult.resolution	
requestedResult.measureSemantic	421026006 Oral tablet (qualifier value)

Note: This should not be confused with “frequency”. Although not stated explicitly, it is understood that the IR states: ONE tablet, twice a day.

Example IR: Acetaminophen 325 mg tablet oral two tablets every 6 hours

Table 1.6. requestedResult -Example 2

requestedResult.lowerBound	2
requestedResult.upperBound	2
requestedResult.includeLowerBound	TRUE
requestedResult.includeUpperBound	TRUE
requestedResult.resolution	
requestedResult.measureSemantic	421026006 Oral tablet (qualifier value)

1.6.17. conditionalTrigger (Request)

Format: Logical Expression

Terminology: TBD

Currently not in use.

1.6.18. conditionalTrigger.statementId (Request)

UUID as identifier for the conditionalTrigger statement.

1.6.19. Priority (Request)

Format: Logical

Expression Terminology: SNOMED CT

The priority field captures the standard priorities associated with a request for action, e.g. stat, routine

1.6.20. repetition.period (Request)

The “repetition.period” has twelve components. Six components for the repetition period start and six components for the repetition period duration. The fields are used to capture WHEN a repeated action should start and HOW LONG the requested action should be repeated.

1. repetition.periodStart.lowerBound

Format: Number (“float”)

2. repetition.periodStart.upperBound

Format: Number (“float”)

3. repetition.periodStart.includeLowerBound

Format: TRUE or FALSE (“Boolean”)

4. repetition.periodStart.includeUpperBound

Format: TRUE or FALSE (“Boolean”)

5. repetition.periodStart.resolution (optional)

Format: Number (“float”)

6. repetition.periodStart.measureSemantic

Format: Logical Expression

1.6.21. repetition.period components

Example IR: Naproxen sodium 550 mg tablet oral every 12 hours as needed for back pain

Table 1.7. repetition.period Example

repetition.periodStart.lowerBound	[NOW,NOW] relative to statement time
repetition.periodStart.upperBound	
repetition.periodStart.includeLowerBound	
repetition.periodStart.includeUpperBound	
repetition.periodStart.resolution	
repetition.periodStart.measureSemantic	
repetition.periodDuration.lowerBound	1
repetition.periodDuration.upperBound	inf
repetition.periodDuration.includeLowerBound	TRUE
repetition.periodDuration.includeUpperBound	FALSE
repetition.periodDuration.resolution	1
repetition.periodDuration.measureSemantic	258703001 day (qualifier value)

If the IR does not explicitly state a period start time, the default entry in this field is “[NOW,NOW] relative to statement time”.

Note: “[NOW,NOW]” is not to be confused with priority “stat”. The “NOW” is simply used where there is not a specified time, e.g. 1 week from now.

If a repetition period start/stop time is specified, the “upper/lower bound” components and the measure-Semantic are used as in all other timing related circumstances.

1.6.22. repetition.periodDuration components

Every repetition has a duration, even if it is not explicitly stated in the IR. In the example above, the IR states a frequency (every 12 hours), but not a duration. In these cases it is understood that the duration is “infinite”. The same understanding is true for IR statements described as “daily”. The “upper/lower bound” components and the “measure.semantic” are used in the same way as in all other timing related circumstances.

Note: The “repetition.periodDuration” fields are currently also used to capture numbers of tablets (or other units) and number of refills, if these are stated in the IR. The tablets/refills are used to calculate how long the administration period can be.

Example IR: Aspirin 81 mg oral tablet daily as needed, 30 tablets, 3 refills

30 tablets + 3 refills = 120 tablets

1 tablet/day = 120 days

Table 1.8.

repetition.periodDuration.lowerBound	1
repetition.periodDuration.upperBound	120
repetition.periodDuration.includeLowerBound	TRUE
repetition.periodDuration.includeUpperBound	TRUE
repetition.periodDuration.resolution	1
repetition.periodDuration.measureSemantic	258703001 day (qualifier value)

1.6.23. repetition.eventFrequency (Request)

This circumstance is used to capture the requested frequency of any repeated action, e.g. 3 times/day, once/week.

The “repetition.eventFrequency” circumstance has six components.

1. repetition.eventFrequency.lowerBound

Format: Number (“float”)

2. repetition.eventFrequency.upperBound

Format: Number (“float”)

3. repetition.eventFrequency.includeLowerBound

Format: TRUE or FALSE (“Boolean”)

4. repetition.eventFrequency.includeUpperBound

Format: TRUE or FALSE (“Boolean”)

5. repetition.eventFrequency.resolution (optional)

Format: Number (“float”)

6. repetition.eventFrequency.measureSemantic

Format: Logical Expression

Example IR: Naproxen 550mg tablet oral every 12 hours

Table 1.9. repetition.eventFrequency - Example 1

repetition.eventFrequency.lowerBound	12
repetition.eventFrequency.upperBound	12
repetition.eventFrequency.includeLowerBound	TRUE
repetition.eventFrequency.includeUpperBound	TRUE
repetition.eventFrequency.resolution	
repetition.eventFrequency.measureSemantic	258702006 hour (qualifier value)

Example IR: Ibuprofen 400 mg tablet oral every 6 hours; may increase dose frequency to one tablet every 4 hours

Table 1.10. repetition.eventFrequency - Example 2

repetition.eventFrequency.lowerBound	4
repetition.eventFrequency.upperBound	6
repetition.eventFrequency.includeLowerBound	TRUE
repetition.eventFrequency.includeUpperBound	TRUE
repetition.eventFrequency.resolution	
repetition.eventFrequency.measureSemantic	258702006 hour (qualifier value)

The “upper/lower bound” components and the measureSemantic are used as in all other timing related circumstances.

1.6.24. repetition.eventSeparation (Request)

Currently not in use.

1.6.25. repetition.eventDuration (Request)

This circumstance will be used to capture, HOW LONG each requested event should last, e.g. “Physical therapy 3 times per week for 1 hour.”

Currently not in use.