An analysis of Observable Entities

David Markwell 2007-01-02 – Progress Report

1. Status

This is a draft report that is intended for the Modeling Consistency Task Force (MCTF)[1]. It is probably not ready for sharing with CMWG or SISB in its current form. Wider discussion prior to further detailed consideration by the MCTF would probably not help us move towards a consistent recommendation. The intention is that this report should be used to assist a decision on how best to continue and complete the investigation.

2. Introduction

2.1. Background

This is a short draft report of work I have been doing to try to find a way to enable SNOMED content to be revised and remodeled to handle observables and observation procedures more effectively. The basis for this work is the decision by SISB in October to investigate a consistent approach to labeling result values using observation procedures.

2.2. Previous work

The requirements for changes to create a more consistent approach to this topic were outlined in the paper "Representation Results with SNOMED CT" dated 2006-09-06. That paper followed several rounds of discussion in various forums including SISB and CMWG.

2.3. Other factors

Growing interest in convergence with Lab LOINC and with IFCC/IUPAC also provide impetus for resolution in this area. On the one hand both of these sources have the potential to add value while on the other they add to the potential for alternative approaches. However, the common factor is that plans for convergence provide a further incentive for resolving the model.

2.4. Proposed approach

The approach under investigation involves recommending that records of instances of results should always be labeled with a "procedure" concept (i.e. the procedure by which the observation was made) rather than with the "observable entity" concept.

The idea behind this is that offering a single way to represent this type of information would be valuable as compared with the current situation in which two approaches are possible for some types of results while others can be done in one way or the other.

2.5. Open questions and areas of agreement

The proposed approach remains controversial. Some people take the view that the appropriate values for labeling results are the "observable entity" concepts, with the procedure concepts used to refine the method of observation where necessary. Others continue to feel that supporting dual concepts (i.e. an "observation procedure" and an "observable entity") may be unnecessary. In spite of these differences there is strong agreement within the CMWG and SISB on the urgent requirement for more consistent modeling of concepts related to observables and on the need for clearer recommendations on implementation.

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[1] The Modeling Consistency Task Force is the current CAP based group but depending on reorganization the responsibility may be transferred to a similar group within the SSDO. The recommendation is that this topic should be given detailed consideration by a small group with a good understanding of the Concept Model before wider discussion by the CMWG or SISB.

Therefore, the primary aim of the work described in this paper is to find an effective way to deliver this consistency. If this is achieved, then the specific advice on recording results may well be less significant – since either approach will be transformable to the other. Conversely without a consistent model any recommendation on representation will at best be a stop gap.

2.6. Scale of the task

The scale of the task is to say the least daunting as it potentially affects the modeling of over 24,000 concepts or approximately 7% of the total active content of SNOMED Clinical Terms. The scope is summarized by Table 1, while the tables on the following pages provide a more detailed breakdown. The more detailed tables show the distribution of the content between the main high level concepts within the "Observable entity", "Laboratory procedure" and "Evaluation procedure" hierarchies.

Table 1. Number of concepts potentially affected

Laboratory procedures	**9,540**
Evaluation procedures	**+ 7,380**
Subtypes of both "evaluation procedure" and "laboratory procedure"	**– 539**
Total of observation procedures	**16,781**
Observable entities	**+ 7,639**
Total concepts	**24,420**

2.7. Breaking down the task

Effective progress requires optimum use of modeling resources supported by tools that provide automated assistance and quality assurance. Prerequisites for this include agreement on modeling rules and identification of priority areas in which to focus initial work and validation.

One step towards this is an audit of the current content to enhance a shared understanding of:

- the nature of the concepts that are already part of SNOMED CT;
- the overlaps between observation procedures and observable entities;
- the general types of observables covered in each of the three relevant hierarchy branches.

The detailed breakdowns in the tables on the following pages identify the high-level categories and some of the more detailed concepts that also have a large number[2] of descendant subtypes. The objective of this breakdown is to provide a focus for further analysis of the concepts and to assess the extent of automated processing that may be possible and the amount of manual review work likely to be required.

[2] The breakdowns include the direct subtype children in each of the three hierarchies and concepts from the next two levels in the hierarchy with more than 100 subtype descendants. Some grouper concepts are omitted where these contain concepts that are also present in other branches of the same hierarchy.

Table 2 Observable entity subtype breakdown

ConceptId	*Fully Specified Name*	*Subtypes*
363787002	**Observable entity (observable entity)**	**7639**
363788007	Clinical history/examination observable (observable entity)	4968
364644000	Functional observable (observable entity)	578
363870007	Mental state, behavior / psychosocial function observable (observable entity)	514
364066008	Cardiovascular observable (observable entity)	483
364561008	Musculoskeletal observable (observable entity)	388
364402001	Body region observable (observable entity)	356
363926002	Eye/vision observable (observable entity)	350
364178005	Urogenital observable (observable entity)	311
364386000	Endocrine, nutritional and metabolic observable (observable entity)	306
363820009	Neurological observable (observable entity)	250
364048003	Respiratory observable (observable entity)	215
363789004	General characteristic of patient (observable entity)	143
364319003	Pregnancy, childbirth / puerperium observable (observable entity)	137
364110006	Oral cavity, dental / salivary observable (observable entity)	106
416342005	Procedure related observable (observable entity)	103
246464006	Function (observable entity)	1479
18373002	Nervous system function (observable entity)	386
106079008	Digestive system function (observable entity)	214
106183005	Immunologic function (observable entity)	135
106029005	Musculoskeletal function (observable entity)	128
78064003	Respiratory function (observable entity)	112
414237002	Feature of entity (observable entity)	963
414236006	Feature of anatomical entity (observable entity)	739
396277003	Fluid observable (observable entity)	161
415178003	Process (observable entity)	412
255324009	Movement (observable entity)	250
257733005	Activity (observable entity)	141
160476009	Social / personal history observable (observable entity)	326
395531003	Tumor observable (observable entity)	296
364708003	Sample observable (observable entity)	123
228859002	Radiation therapy observable (observable entity)	108
46680005	Vital sign (observable entity)	106
278844005	General clinical state (observable entity)	84
408699006	Device observable (observable entity)	80
243814003	Interpretation of findings (observable entity)	72
364684009	Body product observable (observable entity)	59
364713004	Temporal observable (observable entity)	53
364709006	Hematology observable (observable entity)	23
414755005	Molecular, genetic AND/OR cellular observable (observable entity)	22
363819003	Drug therapy observable (observable entity)	21
105727008	Age AND/OR growth period (observable entity)	12
399060005	Imaging observable (observable entity)	10
397793000	Monitoring features (observable entity)	5
373063009	Substance observable (observable entity)	4
409652008	Population statistic (observable entity)	3
409599009	Laboratory biosafety level (observable entity)	1

Table 3 Laboratory procedure breakdown

ConceptId	*Fully Specified Name*	*Subtypes*
108252007	**Laboratory procedure (procedure)**	**9540**
108257001	Anatomic pathology procedure (procedure)	346
9265001	Specimen processing (procedure)	69
108261007	Chromosome analysis, cytogenetic procedure AND/OR molecular biology method (procedure)	188
55284006	Chemical method (procedure)	356
127790008	Staining method (procedure)	304
108261007	Chromosome analysis, cytogenetic procedure AND/OR molecular biology method (procedure)	188
108262000	Molecular biology method (procedure)	153
252144003	Biochemical test (procedure)	3812
74040009	Protein measurement (procedure)	729
108270005	Specific drug AND/OR toxicology test (procedure)	195
104780002	Lipids measurement (procedure)	124
108269009	Drug monitoring procedure AND/OR toxicology screen (procedure)	121
83762000	Chemical procedure (procedure)	3438
122444009	Enzyme measurement (procedure)	373
108270005	Specific drug AND/OR toxicology test (procedure)	195
27419005	Amino acids measurement (procedure)	191
105036000	Tissue preparation for drug analysis (procedure)	133
104780002	Lipids measurement (procedure)	124
108269009	Drug monitoring procedure AND/OR toxicology screen (procedure)	121
84894008	Molecular biology identification technique (procedure)	138
252318005	Immunology laboratory test (procedure)	2462
127795003	Laboratory test related to immunohematology (procedure)	289
108267006	Immunologic procedure (procedure)	2901
33468001	Hematology procedure (procedure)	989
252275004	Hematology test (procedure)	472
127795003	Laboratory test related to immunohematology (procedure)	289
127791007	Laboratory test related to hemostasis (procedure)	274
19851009	Microbiology procedure (procedure)	983
395124008	Viral studies (procedure)	277
61594008	Microbial culture (procedure)	176
4804005	Microbial identification test (procedure)	136
122445005	Hormone measurement (procedure)	528
59524001	Blood bank procedure (procedure)	400
252314007	Blood transfusion test (procedure)	135
44608003	Blood group typing (procedure)	124
121277008	Steroid measurement (procedure)	194
127801007	Body fluid analysis (procedure)	130
118218001	Cell count (procedure)	126
396550006	Blood test (procedure)	126
43782000	Organ or system related test (procedure)	107
363778006	Phenotype determination (procedure)	106
252335009	Cell phenotyping (procedure)	102

Table 4 Evaluation procedure breakdown (part 1)

ConceptId	*Fully Specified Name*	*Subtypes*
386053000	**Evaluation procedure**	**7380**
363679005	Imaging (procedure)	2814
371571005	Imaging by body site (procedure)	2415
108273007	Topography specific radiographic procedure (procedure)	1366
363244004	Nuclear medicine study by site (procedure)	317
363335003	Ultrasound studies by site (procedure)	301
303780008	Regional contrast radiology (procedure)	287
303748006	Digestive system contrast procedure (procedure)	101
414459003	Imaging of upper limb (procedure)	157
74170002	Radiography of upper limb (procedure)	105
363141001	Imaging of neck (procedure)	128
414458006	Imaging of spine (procedure)	113
413815006	Chest imaging (procedure)	112
363680008	Radiographic imaging procedure (procedure)	1513
77343006	Angiography (procedure)	623
108273007	Topography specific radiographic procedure (procedure)	1366
60654006	Diagnostic radiography of abdomen (procedure)	374
363276009	Radiographic procedure on musculoskeletal system (procedure)	269
29357002	Radiography of face, head AND/OR neck (procedure)	245
303939005	Fluoroscopy of regions (procedure)	242
363278005	Radiographic procedure on pelvic region (procedure)	217
363023007	Computerized axial tomography of site (procedure)	206
363275008	Radiographic procedure on lower extremity (procedure)	127
74170002	Radiography of upper limb (procedure)	105
303748006	Digestive system contrast procedure (procedure)	101
27483000	Diagnostic radiography with contrast media (procedure)	461
303748006	Digestive system contrast procedure (procedure)	101
44491008	Fluoroscopy (procedure)	288
303939005	Fluoroscopy of regions (procedure)	242
77477000	Computerized axial tomography (procedure)	238
363023007	Computerized axial tomography of site (procedure)	206
16310003	Diagnostic ultrasonography (procedure)	369
363335003	Ultrasound studies by site (procedure)	301
108288002	Ultrasound procedure on topographic region (procedure)	268
303911009	Ultrasound studies of systems (procedure)	118
373205008	Nuclear medicine imaging procedure (procedure)	369
363244004	Nuclear medicine study by site (procedure)	317
113091000	Magnetic resonance imaging (procedure)	150
5880005	Physical examination procedure (procedure)	2554
284365007	Examination of body site (procedure)	1940
284366008	Examination of body system (procedure)	1817
36228007	Ophthalmic examination and evaluation (procedure)	294
268925001	Examination of respiratory system (procedure)	276
284393006	Examination of joint (procedure)	113
108191006	Abdomen endoscopy (procedure)	536
14563007	Endoscopy of pelvic cavity (procedure)	217
120200004	Pelvis endoscopy (procedure)	326
14563007	Endoscopy of pelvic cavity (procedure)	217
274380008	Urinary endoscopy (procedure)	174
302773001	Examination of limb (procedure)	189

Table 5 Evaluation procedure breakdown (part 2)

ConceptId	*Fully Specified Name*	*Subtypes*
162673000	General examination of patient (procedure)	361
79206001	Specialized medical examination (procedure)	169
243788004	Child examination (procedure)	118
122458006	Exploration procedure (procedure)	350
76145000	Exploratory incision (procedure)	171
363122004	Exploration of trunk (procedure)	121
12894003	Functional assessment (procedure)	157
63332003	History AND physical examination (procedure)	105
276341003	Cardiovascular investigation (procedure)	1097
77343006	Angiography (procedure)	623
129118002	Arteriography (procedure)	320
303827001	Trunk angiography (procedure)	270
241234000	Abdominal angiography (procedure)	129
4970003	Venography (procedure)	134
108276004	Radiographic procedure on cardiovascular system (procedure)	317
113021009	Cardiovascular measurement (procedure)	226
302779002	Vascular function test (procedure)	112
48428001	Cardiovascular monitoring (regime/therapy)	134
276343000	Urogenital system investigation (procedure)	747
281011001	Examination of urinary system (procedure)	206
274380008	Urinary endoscopy (procedure)	174
108279006	Radiographic procedure on genitourinary system (procedure)	141
83607001	Gynecologic examination (procedure)	127
302777000	Gastrointestinal investigation (procedure)	554
118155006	Gastrointestinal tract endoscopy (procedure)	189
75679007	Radiography of gastrointestinal tract (procedure)	108
182777000	Monitoring of patient (regime/therapy)	546
170549007	Chronic disease monitoring (regime/therapy)	281
48428001	Cardiovascular monitoring (regime/therapy)	134
122869004	Measurement procedure (procedure)	427
41751005	Anatomic measurement (procedure)	330
64777005	Physiologic measurement (procedure)	251
276342005	Ophthalmological and optical investigations (procedure)	218
252801000	Ophthalmological test (procedure)	135
399210005	Neurological investigation (procedure)	185
270913004	Neuroelectrophysiology test (procedure)	123
363074004	Diagnostic procedure on respiratory system structure by site (procedure)	169
26231004	Diagnostic procedure on respiratory tract (procedure)	167
108249004	Audiologic AND/OR audiometric test including vestibular function (procedure)	146
91005004	Audiological evaluation (procedure)	126
398171003	Hearing examination (procedure)	122
252314007	Blood transfusion test (procedure)	135
51481005	Antibody identification, RBC (procedure)	104
51860002	Diagnostic procedure on musculoskeletal system (procedure)	134
373366005	Diagnostic procedure on eye region (procedure)	131
44608003	Blood group typing (procedure)	124
84100007	History taking (procedure)	120
63332003	History AND physical examination (procedure)	105

Table 6 Evaluation procedure breakdown (part 3)

ConceptId	*Fully Specified Name*	*Subtypes*
14736009	History and physical examination with evaluation and management of patient (procedure)	95
84028004	Diagnostic procedure on soft tissue (procedure)	93
53115007	Diagnostic dental procedure (procedure)	62
386042006	Immune system evaluation (procedure)	52
167217005	Urine examination (procedure)	37
271992004	Obstetric investigation (procedure)	36
91512002	Diagnostic procedure on breast (procedure)	36
234745004	Take oral or dental impression (procedure)	32
363779003	Genotype determination (procedure)	24
373361000	Diagnostic procedure on visual pathway (procedure)	16
164790002	Breath test (procedure)	14
120646007	Antibody screen (procedure)	12
15695009	Stimulation test (procedure)	12
52424002	Provocative test (procedure)	11
129106006	Diagnostic procedure on ear (procedure)	11
108243003	Sleep disorder test AND/OR procedure (procedure)	11
110463001	Therapeutic evaluation (procedure)	11
164961002	Physiological function tests (procedure)	7
168122003	Sample examination - general (procedure)	7
363109007	Evaluation of test results (procedure)	7
108224003	Preventive patient evaluation (procedure)	6
30527007	Diagnostic procedure on liver (procedure)	6
103705002	Patient status observation (procedure)	5
417602003	Osteopathic evaluation procedure (procedure)	4
50947004	Suppression test (procedure)	3
110466009	Pre-surgery evaluation (procedure)	3
70930004	Disease condition determination (procedure)	2
169208003	Physics: other diagnostic methods (procedure)	2
105408001	Spiritual assessment (procedure)	2
53973008	Genetic investigation procedure (procedure)	2
55034008	Ward laboratory procedure, screening (procedure)	1
61788003	Ward guaiac test (procedure)	1
67407003	Determination of outcome (procedure)	1
7918005	Ward glucometer test (procedure)	1
19681004	Nursing evaluation of patient and report (procedure)	1
20481000	Determination of prognosis (procedure)	1
24727006	Temperature gradient studies (procedure)	1
180574001	Compartment pressure studies (procedure)	1
165197003	Diagnostic assessment (procedure)	1
110462006	Health technology assessment procedure (regime/therapy)	1
312948004	Karyotype determination (procedure)	1
370802002	Evaluation of postoperative tissue perfusion (procedure)	1
270914005	Psychological analysis (procedure)	1
275294003	Blood volume estimation (procedure)	1
398045004	Estimation of regional perfusion (procedure)	1
398272001	Post-anesthesia assessment (procedure)	1
409655005	Bone marrow culture (procedure)	1
409870009	(1-->3)-beta-D-glucan detection (procedure)	1
413043003	Saliva examination (procedure)	1

3. Analysis of observable entities

3.1. Introduction

The proposal accepted for testing that SISB accepted at its October 2006 meeting is reiterated in Reference 1. To begin the first phase of this proposal an analysis of the current content of "observable entity" was conducted to attempt to identify those concepts for which the addition of a related "procedure" concept was appropriate. This analysis is described in more detail in the following sections.

Reference 1. Excerpt from proposal discussed by CMWG in October 2006

First phase of the proposal

The proposed approach which is the subject of this consultation is as follows:

1. Check all observable entities for matching observation procedures.
   - Where these are found add the relevant "has observable" relationship.
   - Where these are not found either
     - The concept is not an observable entity (true of some concepts in this hierarchy in the current release - e.g. "function" and its subtypes).
       - These need to be remodeled as part of another hierarchy.
     - The concept is a general type of observable entity that cannot be observed by a specified procedure (e.g. "vital signs").
       - These can be left without relevant procedures as there is no specific result that can be labeled with them.
     - If neither of these apply
       - Add a new "observation procedure" and the appropriate "has observable" relationship.
2. When this process is complete
   - Update existing implementation guidance to recommend that the "observation procedure" concepts should be used to label the results of observations in all cases.
     - The current exceptional handling of clinical observations and assessments would no longer apply.
3. "observable entity" concepts would remain
   - In the second phase (see below) more "observable entity" concepts would be added to provide appropriate defining values for the existing "measurement procedure" and "laboratory procedure" concepts.

Second phase of the proposal

A second phase activity would then seek to align the model for all "observation procedures" (i.e. all procedures that can be used to label results). This would involve:

4. Review of all "measurement procedure" and "laboratory procedure" concepts
   - If the procedure concept already has a "has observable" relationship (will only apply to content added in phase 1).
     - No further action needed.
   - If an appropriate "observable entity" concept exists
     - A "has observable" relationship to this concept.
   - Otherwise consider the nature of the "observable entity" that is measured and add the necessary concept and "has observable" relationship.

3.2. Method

3.2.1. Substrate for analysis

Initially all concepts that are subtype descendants of the concept "observable entity" in the July 2006 release were analyzed. However, review of the results suggests that subtypes of the concepts "function" and/or "process" rarely fit the criteria for entities that can be assigned results in their own right. This finding reinforced concerns raised in previous discussions in CMWG which have suggested that functions and processes are qualitatively different from other concepts in the observable entity hierarchy[3]. This does not necessarily imply that these concepts are not "observable entities". However, excluding them from processing during the first phase of the proposal is likely to simplify progress without significantly affecting the benefits.

3.2.2. Analysis criteria

The analysis involved iterative development of a set of lexical criteria that were applied to the Fully Specified Names of all the subtypes of the concept "Observable entity".

The nature of the value of an observable entity (or the result of an "observation procedure") is determined by the "kind of property" observed. Therefore, analysis criteria were designed to match words likely to indicate particular kinds of property. The kinds of property identified were organized into a provisional subtype hierarchy. In addition a distinction was made between "kinds of property" that are commonly expressed as quantitative values.

> For example, the words "height", "length", "width" and "circumference" all suggest measurement of a linear dimension. In contrast, the words "shape", "color" and "texture" all suggest a qualitative observation of a feature of a physical object.

After each application of the criteria samples were manually reviewed to identify additional criteria. The hierarchy of "kinds of property" used in the final pass during this exploratory study is shown in Table 7.

Consideration was also given to the relative indicative power of different criteria where particular terms contained several potentially significant words.

> For example, the words "date" suggests a temporal value while the word "ability" indicates an assessment of performance. The term "ability to remember own date of birth" includes both words but clearly requires an assessment rather than a date. On the other hand, the term "time since loading dose" requires a "time" rather than a "dose" quantity.

The current study has not taken the process of refinement of the rules and specification of indicative power to its limits but has explored the options as far as possible in a limited period of time. Before switching to an individual concept editing mode it is likely that worthwhile results[4] will be achieved by taking this a few steps further and particularly by involving other reviewers in considering the criteria.

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[3] Like physical objects, a function or process can be observed. However, in order to label a result from such an observation it is also necessary to specify the property observed. For example, heart rate, stroke volume, output, systolic blood pressure, etc are observations of "cardiac function" which may have values., It is possible to make observations of the particular aspects of a function or process (e.g. adequacy, duration) or of properties related to a specific function (e.g. "heart rate", "stroke volume", "systolic blood pressure", etc are properties related to cardiac function). The aspects or properties observed are observable entities but they are not subtypes of the function or procedure observed.

[4] The result is only worthwhile if it reduces need for individual editing of several concepts. Since each attempt to refine the criteria takes a finite amount of time to complete a point will be reached where individual concept editing is more productive than rule refinement.

3.2.3. Kinds of property

Table 7 shows the hierarchy of "kinds of property" developed during this study.

The number in square brackets after each name indicates the number of "observable entity" concepts that matched criteria for the specified kind of property (excluding those that met the criteria for a more specific kind). To assess the number of concepts matching a more general set of criteria add the numbers of the subsidiary items in the hierarchy.

> For example there are 167 concepts that match the criteria for distance or linear measurement (20+27+7+31+29+42+11). In practice these include some rogue concepts (e.g. "depth of history").

The terms in brackets after each item indicate synonyms, inverse, similar and possible equivalents.

Items shown in bold indicate kinds of property that typically have quantitative values.

Table 7. A possible hierarchy of kinds of property

- observable entity property kind
  - detail [17]
    - history [6]
    - sign [0]
    - symptom [1]
  - dimension [2] (possible: size)
    - **area [20]**
    - **distance** (synonym: linear dimension)
      - **breadth [20]**
      - **circumference [27]**
      - **depth [7]**
      - **diameter [31]**
      - **height [29]**
      - **length [42]**
      - **width [11]**
    - **volume [106]** (similar: capacity, space)
    - measure [78]
  - feature [495] (synonym: attribute, character)
    - ability [685]
      - acuity [26]
      - mobility [13]
      - motility [4]
      - tolerance [8]
    - appearance [91]
      - color [55]
      - shape [38] (possible: arrangement)
        - angle [13]
        - form [43]
        - symmetry [6]
    - availability
    - category [2]

continues …

continued

- compliance [12]
- content [9]
- dominance [3]
- factor [5]
- **index [70]** (synonym: score)
- mental
  - attention [1]
  - awareness [3]
  - attitude [8]
- odor [14] (synonym: smell)
- patency (13)
- performance (12)
- physical
  - conductance [21] (inverse: resistance)
  - consistency [19]
    - elasticity
  - deformability
  - density [4]
  - permeability [1]
  - resonance
  - tension [5]
  - texture [3]
  - tone [8]
- priority
- property [1]
- quality [11]
  - pattern [42]
    - rhythm [8]
- stability [20]
- state [10]
  - condition [10]
  - maturity [1]
  - status [113]
- type [15]

o fluid

- **concentration [114]** (similar: level)
  - **specific gravity**
  - **pH**
  - **osmolarity**
- solubility
- turbidity [2]
- viscosity [4] (inverse: fluidity)

o force

- potential [20]
- **pressure [197]**
- strength [6]
  - power [8]

o location [10]

- distribution [4]
- position [25]

o miscellany

- adequacy [4]

continues

continued

- multivalue
  - difference [4]
    - change
      - gain
      - loss [14]
  - range [35]
- quantity [250] (synonym: amount)
  (possible: consumption, dose, input, intake, output)
  - **mass [11]**
    - **weight [27]**
  - **number [93]** (synonym: count)
  - **volume [106]** (similar: capacity, space)
- ratio [40]
  - **concentration [114]** (similar: level)
    - **osmolarity**
    - **pH**
    - **specific gravity**
  - **density [4]**
  - **fraction [1]**
  - **gradient [4]**
  - **percentage [8]**
  - **percentile**
  - **proportion [11]**
  - **quotient [7]**
  - **rate [86]**
    - **frequency [29]**
- result [39]
  - reaction
  - response
- stage [13]
  - phase [5]
- **temperature [49]**
- **time** [57]
  - **age [28]**
  - **date [12]**
  - **duration [30]**
  - **interval [8]**
  - latency [9]
  - **period [17]**
- **velocity [29]**
  - **speed [12]**
- wave
  - **amplitude [14]**
  - **rate [86]**
    - **frequency [29]**

3.3. Practical results of the analysis

3.3.1. Observable to Observation Procedure table

The main result of the analysis is a table which maps each "observable entity" concept to a suggested "kind of property" and a suggested fully specified name for a parallel "observation procedure". The naming convention adopted to generate these names is as follows:

Where the "kind of property" is typically expressed as a quantitative value the prefix "measurement of …" is applied.

Where the "kind of property" is qualitative the prefix "observation of … " is applied.

Manual review of the resulting parallel hierarchy (structured initially in accordance with the observable entities from which each procedure was derived) revealed some obvious anomalies that are commented on specifically in the following table. Manual adjustments have been made to the table in these cases.

Most of the observation procedures identified do not exist in the current release of SNOMED CT and need to be added. Those observation procedures that do exist have been indicated by inclusion of the relevant conceptId.

This table is similar in some ways to the SEP table developed by Kent Spackman for the Anatomy section. It provides a convenient internal representation for review of the actions required to implement the proposed changes.

At this stage this table exists in a highly provisional form that requires further work and review before it can be used in practice.

3.3.2. Observable entity review comments

While reviewing the provisional mappings described in 3.3.1 comments on particular concepts and sets of concepts were captured for future reference. These comments are presented in the following two tables.

Table 8 includes comments on reasons for including or excluding various concepts and subtypes from the parallel set of "observation procedure" concepts.

Table 9 includes incidental comments on other specific issues with various observable entity concepts.

Table 8. General comments related to addition of observation procedures

Comment	ConceptId	FullySpecifiedName	Subtypes
Functions not observable. These could be the subject of specific observations but the nature of the observable would need to be specified rather than just the function. Observation procedure probably not required	246464006	Function (obs ent)	1479
Process not observable entity Like functions these may be the focus of an observation but they are not observables in their own right. Observation procedure probably not required	415178003	Process (obs ent)	412
Kind of property General properties of masses. Could be applied to any mass but in each case would need to specify the mass.	364639007	Feature of a mass (obs ent)	15
Kind of property Does not specify on what this was observed.	250532000	Crystal birefringence (obs ent)	1
Kind of property Observations about a substance in the general sense rather than in the specific sense applicable to an	373063009	Substance observable (obs ent)	4

Comment	ConceptId	FullySpecifiedName	Subtypes
entity. Observation procedure probably not required			
Kind of property General concepts are “kinds of property” applicable to any fluid rather than an observable entity in their own right. Should include kinds of properties applicable to any fluid (i.e. viscosity) However, this concepts also has subtypes that are specific to particular fluids. (Eg. 106090003 | body fluid property |, 416251000 | feature of circulating blood |) these subtypes should be defined by reference to the kinds of property rather than being subtypes of this kind of quantity node.	396277003	Fluid observable (obs ent)	161
Headings under which descriptive content is likely to be used No need for these to have procedures except perhaps at very general level "social and personal history taking". Observation procedure probably not required	160476009	Social / personal history observable (obs ent)	326
Product parameters and settable parameters Probably should not add these as observation procedures even though they can also be observed. Observation procedure probably not required	228859002	Radiation therapy observable (obs ent)	108
	252116004	Observation parameter (obs ent)	45
	397793000	Monitoring features (obs ent)	5
	116857008	Blood product unit attribute (obs ent)	10
	408699006	Device observable (obs ent)	80
	363962001	Feature of artificial lens (obs ent)	19
	405678007	Rate of administration of intravenous fluid (obs ent)	1
	399264008	Image mode (obs ent)	1
Product parameters and settable parameters Most of these are specified rather then determined by observation	373064003	Drug observable (obs ent)	12
Site specified Does not seem appropriate for mapping to “observation procedure” as these site may be specified rather than observed.	384727002	Specimen laterality (obs ent)	1
	396991001	Biopsy site (obs ent)	1
	396995005	Aspirate site (obs ent)	1
Hematology observables. Relevant procedures exist for some of these. Others need to be put in appropriate locations.	364709006	Hematology observable (obs ent)	23
Statistical observable Observation procedure probably not required	409653003	Case fatality rate (obs ent)	1
	409651001	Mortality rate (obs ent)	1
	409652008	Population statistic (obs ent)	3
Statistical observable General type of statistical score not a specific observable as it must be applied to something that has been observed.	58577001	LOD score (obs ent)	1
Times This and subtypes do not seem to be appropriate for mapping to “observation procedure”	364713004	Temporal observable (obs ent)	53
Further review Mixed set that needs more detailed review	364708003	Sample observable (obs ent)	123

Comment	ConceptId	FullySpecifiedName	Subtypes
Further review Needs further consideration Observation procedure probably not required	395531003	Tumor observable (obs ent)	296
Further review One off - where does this belong? Observation procedure probably not required	409599009	Laboratory biosafety level (obs ent)	1
Some subtype concepts seem too specialized for procedure in their own rights	364684009	Body product observable (obs ent)	59
Anatomical feature These would benefit greatly from a reference to the relevant body structure.	414236006	Feature of anatomical entity (obs ent)	739
Mixed set of intepretations The concepts in this section are mixed between specific interpretations (e.g. 271930005 | dermatological test interpretation |), groupers of findings (e.g. 271914002 | ENT examination finding |) and one general type of observable (58577001 | LOD score | --> | Log of the odds score |) and one finding (268926000 | resp. system examined - NAD | NAD -- > No Abnormality Detected)	243814003	Interpretation of findings (obs ent)	72

Table 9. Incidental comments related to observable entity anomalies

ConceptId	FullySpecifiedName	Comment	Sub-types
62970001	Osmolarity (obs ent)	Duplicates: 56953008 | osmolality | But based on its subtypes perhaps this concept should be "osmolar gap"?	3
56953008	Osmolality (obs ent)	Duplicates: 62970001 | Osmolarity | (but the other concept may be wrongly named)	2
406643003	World Health Organization Antiretroviral therapy guidelines (obs ent)	Should have initialCapitalStatus set	1
		Not an observable as expressed	1
371440003	Cancer protocol observable (obs ent)	As stated is not about a sample	1
396281003	Other organ present in surgical specimen (obs ent)	Present - suggests context Use of "other" suggests this has context relation to a specified organ meant to be in the specimen.	1
405996001	Presence of fetal anomaly in specimen (obs ent)	Present - suggests context	1
396274005	Organ present in surgical specimen (obs ent)		1
397477008	Presence of fetal tissue in specimen (obs ent)		1
364447000	Feature of abdominal appearance (obs ent)	Probably a subtype of: 414236006 | feature of anatomical entity |	5
111951006	Longevity (obs ent)	Not clear how this differs from age when applied to subject.	1
397191008	Specimen integrity (obs ent)	Supertype is general but subtypes are highly specific to nature of specimen.	3

ConceptId	FullySpecifiedName	Comment	Sub-types
414755005	Molecular, genetic AND/OR cellular observable (obs ent)	The value of this grouper is unclear.	22
399435001	Specimen measurable (obs ent)	Most are general but some are specific to a site (e.g. 396934006 | diameter of optic nerve in specimen | , 396933000 | length of optic nerve in specimen |, 372279008 | percentage of prostatic tissue involved by carcinoma |)	44
20587003	Paternal age (obs ent)	Appears context-dependent - ie subject relationship context explicit.	1
32864002	Senility (obs ent)	Typically this would be an observation of mental health not some much of age	1
268926000	Resp. system examined - NAD (obs ent)	Should be a finding NAD = no abnormality detected	1
13506008	Maternal age (obs ent)	Appears context-dependent – i.e. subject relationship context explicit.	1
413943001	Date chemotherapy completed (obs ent)	Is this something asserting rather than observed – i.e. you assert that the course was completed at a given date rather than finding this out by asking? assertion of ...	1
269902007	Feces foreign constituent (obs ent)	Probably a subtype of: 249622004 | contents of stool |	2
269903002	Feces pancreatic effects (obs ent)	Probably a subtype of: 364690008 | appearance of stool |	2
406094009	Number of mitoses per 10 high power fields (obs ent)	Probably a subtype of: 371472000 | mitotic count score | Includes units	1
250430006	Color of specimen (obs ent)	Probably a subtype of: 407708003 | sample appearance |	5
249551008	Abdominal percussion note feature (obs ent)	Probably a subtype of: 414236006 | feature of anatomical entity |	5
417595002	Cell feature (obs ent)	Probably a subtype of: 414236006 | feature of anatomical entity |	18
371892002	Delivered radiation dose (obs ent)	In wrong hierarchy should be in 228859002|radiation therapy observable|	1

4. Open issues, proposed options and next steps

4.1. Definition of "observable entity"

The current definition of "observable entity" in the User Guide (see Reference 2) includes the word "procedure". This adds to the confusion around this topic because an "observable entity" is not a type of procedure. A suggested revised definition and a definition of "observation procedure" (or if preferred "evaluation procedure") is included as Reference 3.

Reference 2. Observable entity according to the User Guide (July 2006)

Observable entity
Concepts in this hierarchy can be thought of as representing a question or procedure which can produce an answer or a result. For instance, *Left ventricular end-diastolic pressure (observable entity)* could be interpreted as the question "What is the left ventricular end diastolic pressure?" or "What is the measured left ventricular end-diastolic pressure?" Observables are elements that could be used to code elements on a checklist or any element where a value can be assigned. *Color of nail (observable entity)* is an observable. *Gray nails (finding)* is a finding, having a parent of *Nail discoloration (finding*).

One use for *Observable entities* in a clinical record is to code headers on a template. For example, *Gender (observable entity)* could be used to code a section of a template titled "Gender" where the user would choose male or female. "Female gender" would then constitute a finding.

Reference 3. Suggested revised description of Observable Entity and Observation Procedure

Observable entity
Concepts in this hierarchy represent specific properties which have a value that can be observed.
For instance, *Heart rate* is the rate at which a subject's heart is beating. The heart rate may be observed and the value recorded. However, the observable entity (e.g. *heart rate*) is distinct from the procedure of *measuring the heart rate* (e.g. by taking the pulse, apical beat, auscultation or reading a monitor).
Observable entities include qualitative observable (e.g. *Color of nail* or *Skin texture*) as well as quantitative observables (e.g. *Heart rate* or *Head circumference*).
Observable entities can be use to represent elements on a checklist. When a value is assigned to an observable entity the resulting statement is logically equivalent to a finding. For example, if the value "gray" is applied to the observable entity *Color of nail* the meaning is equivalent to the finding *Gray nail (finding)*.

Observation procedure (or evaluation procedure)
Concepts in this hierarchy represent procedures whose primary intended outcome is the acquisition of new information.
For instance, *Apical pulse taking* is the procedure of measuring the pulse or the apex of the heart. This is one of several possible observation procedures that could be used to observe the *heart rate*. The *heart rate* itself is an observable entity which is distinct from (and independent of) the nature of procedure by which it is measured.
Observation procedures include qualitative observations (e.g. *history taking*) as well as quantitative observations (e.g. *Apical pulse taking*).
Observation procedures can be use to request and track the progress of observations. An observation procedure can also be assigned a value representing the result of making that observation. For example, if the value "65/minute" can be applied to the observation procedure *Apical pulse taking* this records the *heart rate* measured by this procedure.

Note applicable to definitions of Observable entity and Observation procedure
Observable entities are closely related to the "Observation procedures". Eventually all Observable entity and Observable procedure concepts will be appropriately interrelated with defining relationships. However, at present some measurements and laboratory procedures related to observables are not currently present or modeled in SNOMED CT. Similarly many clinical observations are represented by Observable entity concepts for which no appropriate Observation procedure concept exists. Until modeling of this area is complete implementers are advised to make use of the Observation procedure concepts and only to use Observable entity concepts where no Observation procedure concept is available. Once modeling is complete the two approaches to representation become safely interchangeable.

4.2. Functions and processes

As noted earlier the subtype of "function" and "process" have been excluded from the consideration of "observable entities". There are currently1479 "Functions" and 412 "Processes". There is an overlap with 78 concepts being subtypes of both "Function" and "Process".

Functions and processes may be reproducibly separable from one another but the current hierarchies are far from URU and the nature of the distinction is unclear. There is no clear definition of either "Function" or Process" as used in SNOMED CT. There are a wide variety of dictionary definitions of "function" and "process". Some of these treat these words as synonymous and few seem to fit their current use in SNOMED CT. The closest fit among the definitions reviewed is shown in Reference 4.

Reference 4. Potential definitions of Function and Process

Function: the actions and activities assigned to or required or expected of an entity.
Process: a sustained phenomenon or one marked by gradual changes through a series of states.

From the perspective of SNOMED CT priorities it may be best to merge these two hierarchies removing the distinction. This seems preferable to an arbitrary (i.e. non-URU) division between them. A possible definition covering both functions and processes is suggested in Reference 5.

Reference 5. Possible merged definition of "function" and "process" as used in SNOMED CT

Function (or **Process**) An action, activity, phenomena, change or set of related actions or changes which may occur to or be carried out by an entity. Note: A function or process may be the subject of an *observable entity*.

4.3. Observables with different characteristics

The study identified a number of concepts in the observable entity hierarchy which have values that are more likely to be "set" or specified than they are to be deliberately "observed" (e.g. 228853001 | radiation treating distance |). These concepts still fit a reasonable definition of "observable entity" since it is obviously possible to observe them and to assign a value to them. However, it seems arcane to include and require the use of a parallel observation procedure such as "measurement of treating distance". It is equally or more likely that parameters such as "radiation treating distance" are set rather than measured.

There are several different categories of observable entities which can be assigned values but which probably need to be distinguished to allow rational use of appropriate concepts:

1. Physiological and other variable personal observables

   E.g. “heart rate”, “systolic blood pressure”, “occupation”

   - These are the kind of observable most attention has been focused on in the past because they are the most widely used in clinical records.
   - It is possible to observe the value in a particular subject at a particular time.
   - It is possible to request the observation be made
   - It is possible to request a particular value.
   - It may be possible to specify a goal or target to be achieved by a course of treatment.
   - It is not possible to precisely set a value but it may be possible to change it in a controlled way.

2. Fixed personal observables

   E.g. “date of birth”, “genotype”, “race”

   - These observable are used in the clinical record but have not been the primary focus of work to date.
   - It is possible to observe the value in a particular subject.
   - It is possible to request the observation be made
   - It is not possible to request a particular value.
   - It is not possible to specify a goal or target to be achieved by a course of treatment.
   - It is not possible to change the value (? except possible gene manipulation).

3. Attributes that can be set in respect of treatment or investigation

   E.g. ”radiation treating distance”, “dose administered”, “length of fasting pre glucose measurement”, “excise rate when measuring heart rate”

   - These observables are used in clinical records but generally as attributes of a treatment or investigation not of the patient.
   - It may be possible to observe the value but is more usual to specify it.
   - It is possible to request the observation be made but it is more usual to specify the value required
   - It is possible to request, specify or set a particular value

4. Fixed attributes of a substance, object or device

   E.g. ”strength of a solution”, “lethal dose 50”, “size of needle”, “intraocular lens power”

   - These observables are used in clinical records but generally as attributes of the drug or device, not of the patient.
   - It may be possible to observe the value but is more usual to specify this as an attribute of the substance or device to be used.
   - It is possible to request the observation be made but it is more usual to specify the value required.
   - It is possible to request or specify the value as an attribute of the substance or device to be used.
   - It is not possible to change the attribute without changing the substance or device.

5. Statistical observable applied to a group or population

   E.g. ”mortality rate”, “LOD score”.

   - These observables are rarely if ever used in individual clinical records but are used in population based statistics.
   - It may be possible to observe the value but the observation is made as a statistical exercise not by direct observation.
   - It is possible to request the observation be made
   - It is possible to specific a goal.
   - It is not possible to request, specify or set a particular value

4.4. Synonym acceptability

The proposed approach to observable, observation procedures and findings creates a logical separation between:

- The observable entity
- The procedure of observing or measuring the value of an observable entity
- A finding related to that observable entity

From a theoretical perspective it would be ideal if these distinctions were reflected by the terms and synonyms attached to concepts in SNOMED CT. There are several reasons why this distinction does not exist at present:

- Historical reasons
  - The lack of “observable entity” concepts in some areas of the hierarchy means that terms like “serum sodium level” have been associated with the nearest matching laboratory procedure concept “sodium measurement, serum”
- Conventions of use
  - Clinicians often make requests using words that literally refer to the “observable entity” even though they are requesting the measurement procedure be carried out and reported. For example “request - serum electrolytes”.
- General finding concepts
  - Some general finding concepts in SNOMED CT have synonyms that sound rather like an observable entity (e.g. 366031009 | Color of iris - finding |) or an observation procedures (e.g. 297985006 | Observation of color of nail bed |).
  - Note: In both these examples the color is not specified thus these concepts do not represent a complete “finding”. It is possible to argue that the issue is no different than any other general concept where one facet is not specified and needs to be refined to create a clinically useful concept. However, the difficulty with this argument is it seems to alter what we mean by a “finding”. If we permit the idea that finding is still a finding even when it is an open question with no answering value then it begs the question of how this differs from an “observable entity”.

The proposed revision of the model will remove the historical motivation for applying logically imprecise terms. However, terms that at face value refer to observable entities may be regarded as synonyms of observation procedures if they are commonly used in this way. The acceptance of common use is a design feature of SNOMED CT and the use of the term “fundus” as a valid synonym for “fundus of eye” illustrates that imprecise synonyms are acceptable and of value[5]. This implies that there is no need for large scale inactivation of Descriptions simply to tidy up the imprecise synonymy between observable entities and observation procedures.

[5] Note that the proposed enhancements to the Descriptions and Language Refsets tables will allow these imprecise synonyms to be distinguished from true synonyms.

However, consideration should be given to the conventions for applying terms and this should evolve alongside the enhancement of the logical model. The high level groupers in the “clinical finding” hierarchy seem to be a challenge in this respect.

A clear distinction can be drawn between the action to measure something and the property that is measured. The idea that a finding is an observable entity to which a specific value or interpretation has been assigned, also seems rational. However, it is more difficult to explain the logical distinction between an observable entity and a general finding to where the value or interpretation is unspecified.

Consider the following two concepts as an example:

- 366031009 | Finding of color of iris (finding) |
- 247030006 | Color of iris (observable entity) |

The current view of the model is that

- “247030006 | Color of iris (observable entity) |
    - Can be given a value (e.g. “blue”) but not refined.

while

- 366031009 | Finding of color of iris (finding) |
    - Can be refined (e.g. 301952009 | Blue iris (finding) |) but not given a value

It is worth reconsidering this distinction. With appropriate relationships it might be possible to remove the need for these types of general finding concepts or to re-cast them as navigational concepts. Once the modeling is complete the “interprets” relationship from relevant observable entities would be used to group findings appropriately.

5. Conclusions

This report has studied some of the options for taking forward the proposal from the October 2006 SISB meeting. A considerable amount of work remains to be done to reach a solid solution. However, the initial results indicate that there are significant opportunities to enhance productivity in making the changes and testing their impact.

Rather than attempt to complete the parallel hierarchy of observation procedures in time for the July 2007 release it would seem more prudent to focus on the most frequently used concepts. These include vital signs and other common daily clinical observation and assessments. Implementing the proposed approach for these concepts would provide a stronger foundation for testing.

As noted in 4.3 the observables hierarchy contains a range of concepts with different characteristics. A consistent solution is needed for all these concepts. However, consistency does not require that concepts with different characteristics be modeled in exactly the same way. Therefore, an approach that focuses first on testing the proposal with physiological and personal variables is preferable to imposing this solution of all concepts in the hierarchy.

Vital signs and most other commonly recorded clinical observables fall within the category of “physiological and personal variables” (see point 4.3 point 1). Therefore, rapid progress with remodeling these concepts is possible without solving all the other issues first. The results of testing in these key areas should be to provide more evidence on which to base future evolution of the model.