Representing Codes in HL7V2

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HL7 Australia November 2011

Current Situation

Codes already in widespread use in V2 in Australia

Mostly not as Values of clinical questions however

HL7 V2 has a variety of Code related data types (From V2.3.1):

- ID: Coded Value for HL7 tables
- IS: Coded Value for User defined tables
- CE: Coded Element
- CF: Coded element with Formatted values
- CWE: Coded With Exceptions
- CNE: Coded with No Exceptions

In Australia have only seen ID, IS and CE in use.

Examples of Use: ID

ID: Coded Value for HL7 tables

A ST (String) field that uses HL7 defined codes in a specific table

No display text

Examples:

MSH-12-Version ID

… |ORU^R01|20050417.736428|P|2.3.1^AUS&&ISO^0.9&&L|…

OBR-25-Result Status

… |200504172206+1000||PHY|C||^^^20050417+1000|…

HL7 Tables are in standard and provide display text for codes

ID values frequently upgraded to CE data type (not yet here)

Coding Scheme then eg: "HL70123"

.. ||PHY|C^Corrected Result^HL70123||…

Examples of Use: IS

IS: Coded Value for User defined tables

Used widely in existing messages:

eg. NamespaceID in HD values, Degree in XCN, Race and Sex in PID

ST (String data type), no display text in messages

In many situations a CE style value is better

Example:

0191322W^ANDERSON^THOMAS^^^DR^M.B.B.S.^^AUSHICPR^L^^^UPIN

IS values are often used where locale specific codes are required

Suggested Values often provided

Can be extended or customised by eg Standards Australia

Display text requires access to User table lookups

Examples of Use: CE
CE: Coded Element

2.8.3 CE - coded element

Components: <identifier (ST)> ^ <text (ST)> ^ <name of coding system (ST)> ^ <alternate identifier (ST)> ^ <alternate text (ST)> ^ <name of alternate coding system (ST)>

Commonly used in Australia – Phased out in later versions

Replaced with CWE and CNE in later versions

Present in many Segments and embedded in complex data types

Concept Representation:

Identifier (ST) eg "3141-9"

Text (ST) eg. "Weight"

Name of Coding System (ST) eg. "LN"

Also allows single alternate code to be transmitted

Example:

2823-3^Serum Potassium^LN^59573005^^SCT

Examples of Use: CE
CE: Coded Element

Alternate Code:

- Equivalent to single Translation of V3 CD datatype
- Must relate to same Concept
  - Can be different levels of specificity
  - eg SNOMED-CT code and ICD10 classification
  - eg. LOINC and SNOMED-CT Lab codes

If no code available can just transmit Text (CWE style)

If Identifier valued should value Coding System

- Can be "L" for local or "99zzz…" where zzz is alphanumeric

If text valued, should be used for display

If expecting IS value then should use code alone (Backward Compatibility)

If HL7 Tables are used use "HL7nnnn" as Coding scheme

- nnnn is zero padded HL7 Table number eg "HL70293"

Examples of Use:
CF: Coded element with Formatted values

2.8.4 CF - coded element with formatted values

This data type transmits codes and the formatted text associated with the code. This data type can be used to transmit for the first time the formatted text for the **canned text** portion of a report, for example, a standard radiologic description for a normal chest X-ray. The receiving system can store this information and in subsequent messages only the identifier need be sent. Another potential use of this data type is transmitting master file records that contain formatted text. This data type has six components as follows:

Components: <identifier (ID)> ^ <formatted text (FT)> ^ <name of coding system (ST)> ^ <alternate identifier (ID)> ^ <alternate formatted text (FT)> ^ <name of alternate coding system (ST)>

Have not seen used in Australian context

Allows HL7 Free Text Formatting commands in Display Text

Potentially entire report could be coded (to single concept)

Examples of Use:
CWE: Coded With Exceptions

2.8.11 CWE – coded with exceptions

Components: <identifier (ST)> ^ <text (ST)> ^ <name of coding system (ST)> ^ <alternate identifier (ST)> ^ <alternate text (ST)> ^ <name of alternate coding system (ST)> ^ <coding system version ID (ST)> ^ alternate coding system version ID (ST)> ^ <original text (ST) >

Backward Compatible with CE Type – replaces it in later versions

Inherits from CE Interface

Not widely used in Australian Context, but in 2.3.1 standards

Allows use of plain text values if no code available

Adds Coding System Version and Original Text

Coding System Version required unless using HL7 Table codes

Original Text is optional

Examples of Use:
CWE: Coded With Exceptions

Table 0353 - CWE statuses

Code	Description
U	Unknown
UASK	Asked but Unknown
NAV	Not available
NA	Not applicable
NASK	Not asked

Allows "Null flavour" type statements when data is unavailable

NASK^Not Asked^HL70353

Examples of Use:
CNE: Coded with No Exceptions

2.8.8 CNE – coded with no exceptions

Components: <identifier (ST)> ^ <text (ST)> ^ <name of coding system (ST)> ^ <alternate identifier (ST)> ^ <alternate text (ST)> ^ <name of alternate coding system (ST)> ^ <coding system version ID (ST)> ^ alternate coding system version ID (ST)> ^ <original text (ST) >

- Backward Compatible with CE Type, Inherits from CE Interface
- Same Interface as CWE but constrained
- Not widely used in Australian Context
- Does NOT allow the use of plain text values if no code available
- Adds Coding System Version and Original Text
- Must use code from a defined value set
- Coding System Version required unless using HL7 Table codes
- Original Text is optional

HL7V2 Evolution

V 2.3.1 Using CE

Figure 7-5. OBX attributes

SEQ	LEN	DT	OPT	RP/#	TBL#	ITEM#	ELEMENT NAME
1	4	SI	O			00569	Set ID - OBX
2	3	ID	C		0125	00570	Value Type
3	80	CE	R			00571	Observation Identifier
4	20	ST	C			00572	Observation Sub-ID
5	65536[3]	*	C	Y4		00573	Observation Value
6	60	CE	O			00574	Units
7	60	ST	O			00575	References Range
8	5	ID	O	Y/5	0078	00576	Abnormal Flags

V 2.6 Using CWE

HL7 Attribute Table – OBX – Observation/Result

SEQ	LEN	DT	OPT	RP/#	TBL#	ITEM#	ELEMENT NAME
1	4	SI	O			00569	Set ID – OBX
2	3	ID	C		0125	00570	Value Type
3	705	CWE	R		9999	00571	Observation Identifier
4	20	ST	C			00572	Observation Sub-ID
5	99999[1]	varies	C	Y[2]		00573	Observation Value
6	705	CWE	O		9999	00574	Units
7	60	ST	O			00575	References Range
8	5	IS	O	Y	0078	00576	Abnormal Flags

Building Forward Compatibility

Should expect Extended Attributes to start appearing

- Anywhere where CE is used, CWE attributes could appear
- Anywhere ID or IS used, CE, CWE or CNE may appear

Parsing of V2 is critical

- Implementation SHOULD ignore what they do not understand
- A CE implementation should consume known fields of CWE
- Meaning, to level know understood, is unchanged
- An ID or IS field should just read Identifier of CE/CWE/CNE

This is not done well currently

- e.g. Units field of OBX - …|mmol/L^^ISO+ |…
- Implementation expecting IS should read "mmol/L"
- Common complaint is "mmol/L^^ISO+" is displayed

Using SNOMED-CT in V2

Simple case is easy:

```
OBX|2|NM|2951-2^Sodium^LN^104934005^^SCT|…
```

For OBX-3 (Observation Identifier) recommend using LOINC

SNOMED-CT can be included as translation

SNOMED-CT is more useful for values:

```
OBX|9|CE|11475-1^Culture^LN|1|112283007^Escherichia coli^SCT|||A|||F
```

The text field can be displayed to the user

In some implementations nothing is displayed

Often converted by Lab or Interface engine to:

```
OBX|9|ST|11475-1^Culture^LN|1|Escherichia coli|||A|||F
```

Universal support for CE values urgently required

Using SNOMED-CT in V2

Reference Terminology provides many Pre-Coordinated concepts

- Will always fall short however
- Ref Sets limit expressiveness and are limiting
  - Many super specialists unhappy with simplifications
  - Snomed-CT itself uses subsumption to cover this
- Example:
- Primary idiopathic hypertrophic cardiomyopathy
- is a type of
- Hypertrophic cardiomyopathy

Requirements of Cardiologist and General Practitioner will vary

- Not enough detail for former, and too much for later

Need to allow terminology to do the heavy lifting, not Ref sets

Using SNOMED-CT in V2

Solution is use of Post-Coordination and inferencing

- Allows extension of terminology to provide extra detail
- Can satisfy super specialists requirements
- Terminology inferencing allows Generalist to use concepts

The question changes slightly:

- Does this patient have "A type of hypertrophic Cardiomyopathy"
- vs Do they have a specific coded concept.

Works for single concepts and Post-Coordinated concepts

Post-Coordination builds a single concept out of an expression: e.g.

```
"64572001|Disease| : 116676008 = 46732000|Malignant Lymphoma,
large B-cell diffuse|"
```

SNOMED-CT in V2

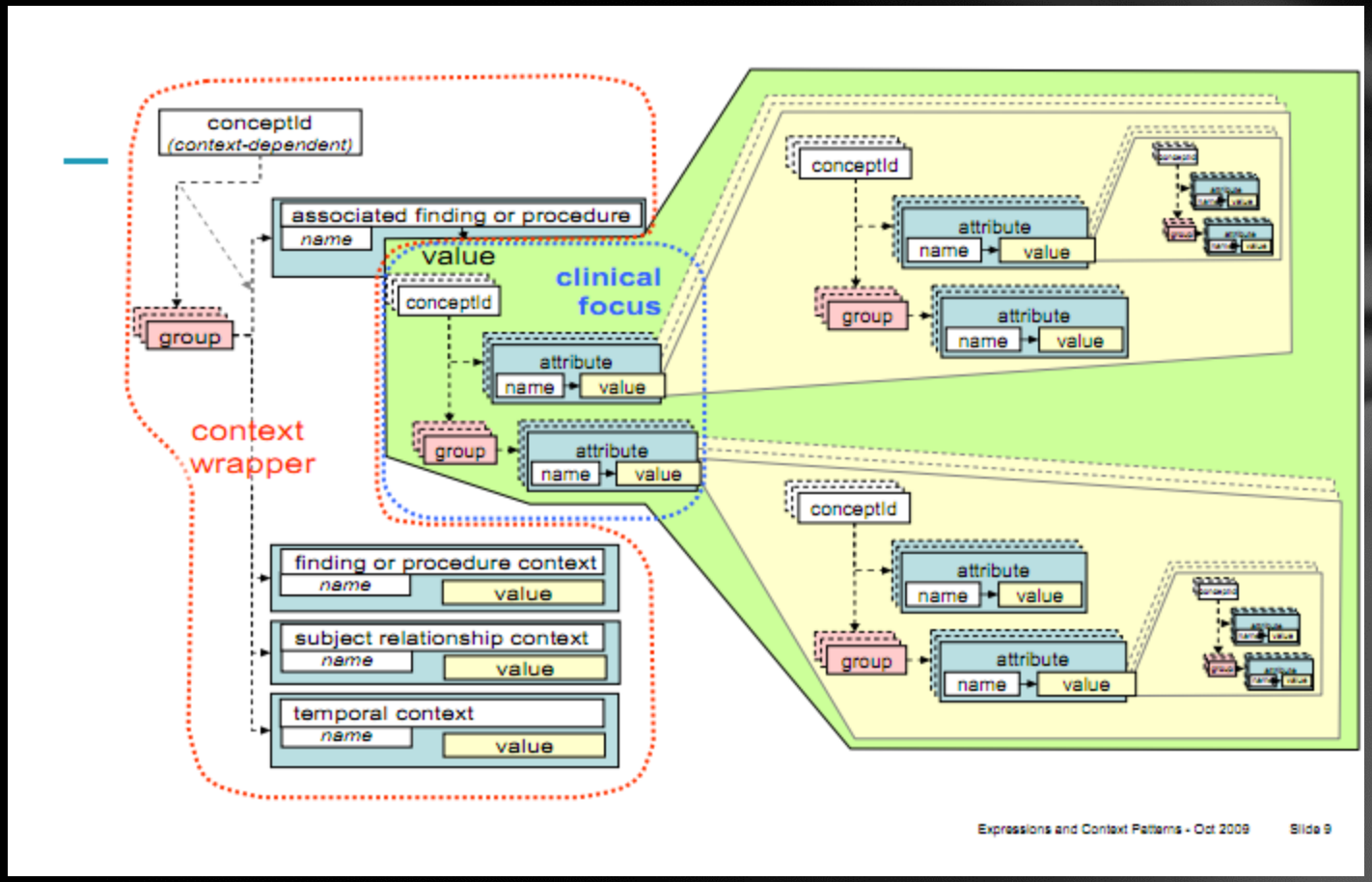
Post Coordinated Concepts:

- Format defined by a grammar
- Can be stored as opaque string
- Length significantly longer than most identifiers
  - Easily > 200 characters at times
- Grammar allows for human readable text – omit in identifier field
- Can be transmitted in CE/CF/CWE/CNE data types

Example:

```
...|64572001:116676008=46732000^Diffuse Large B-Cell Lymphoma^SCT|...
```

SNOMED-CT – Context wrappers



Context is vital in EHR systems and Decision Support

Structure can be provided by Terminology or Information Model

HL7v2 – Information Model

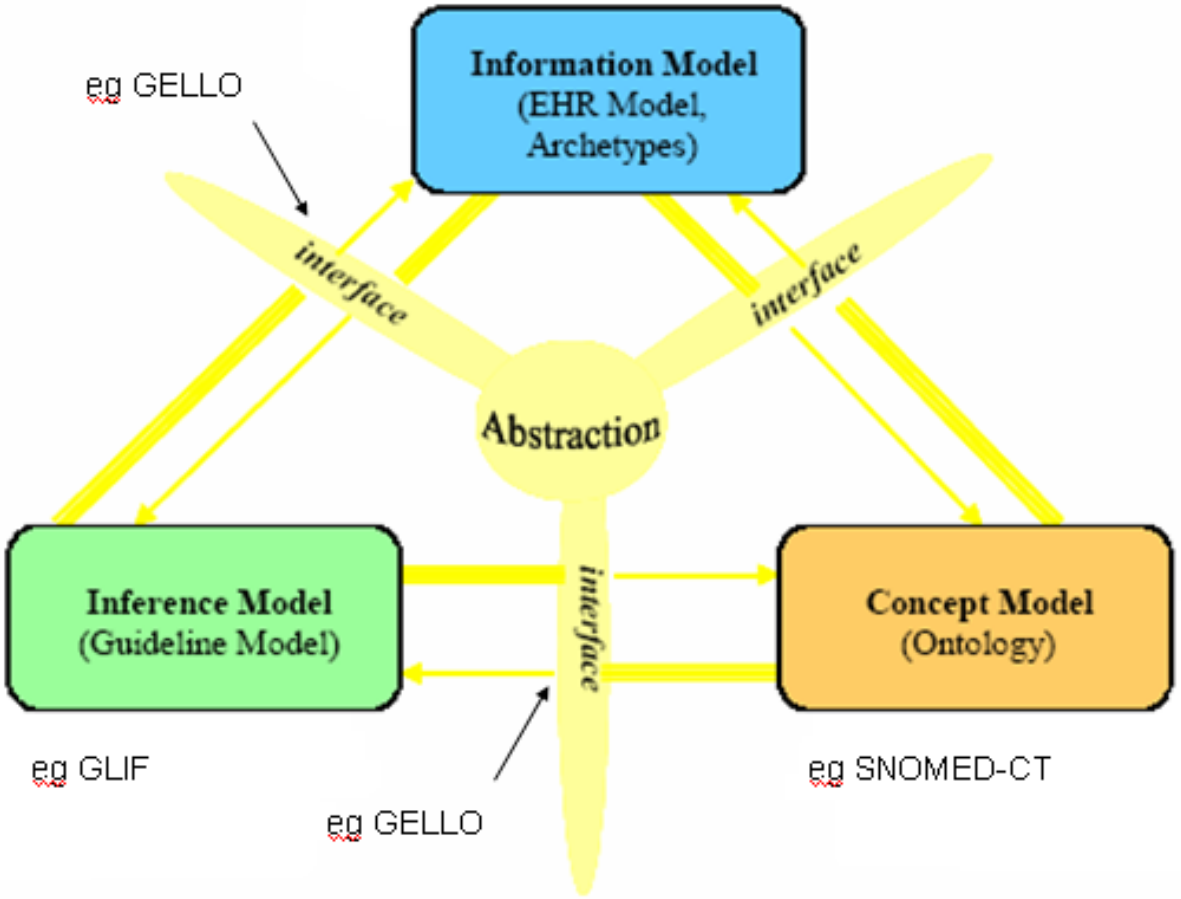
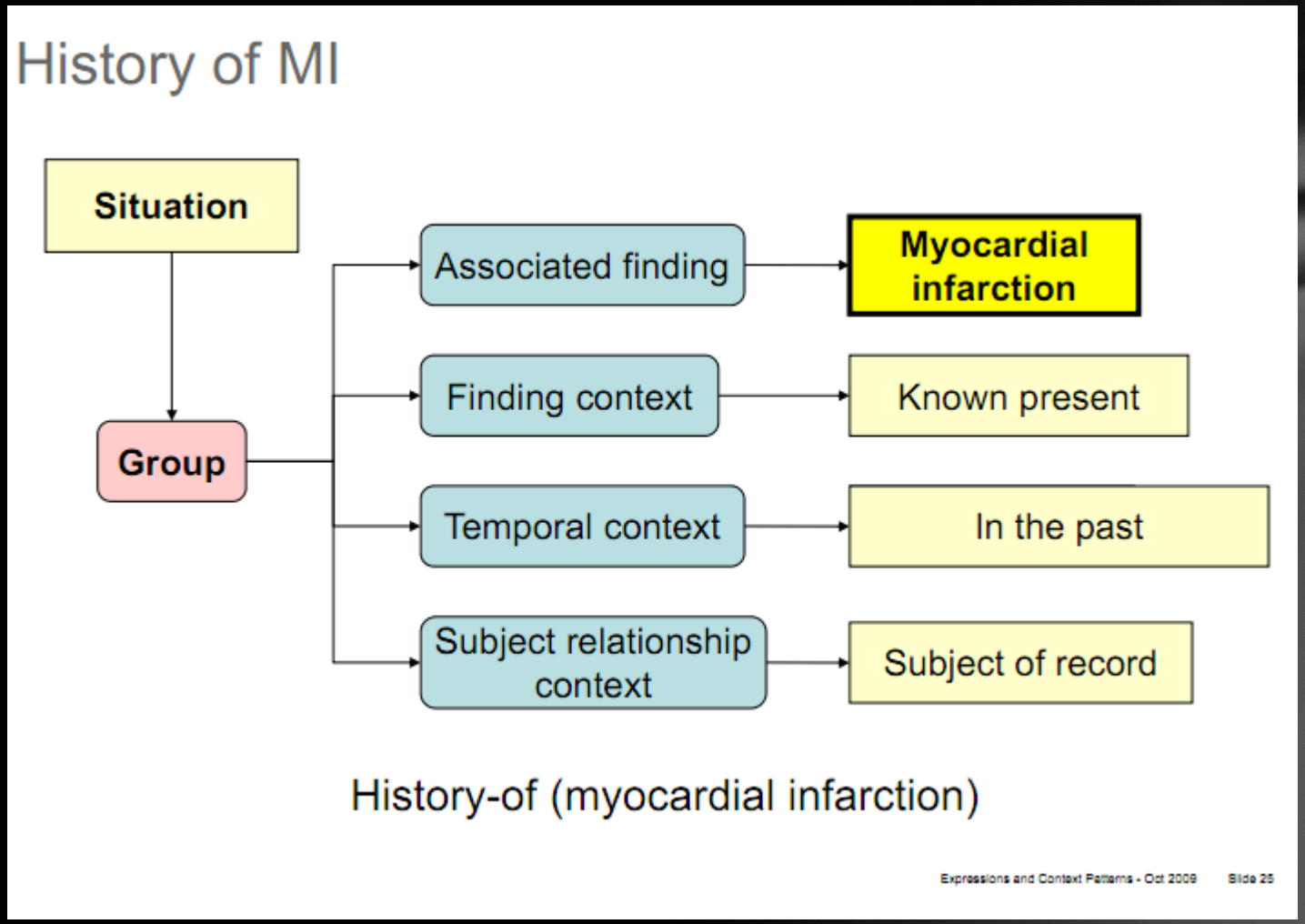


Diagram modified from Alan Rector's "Model of models" found at:

Rector A, Taweel A, Rogers J, (2004) Models and Inference methods for Clinical Systems: A Principled Approach, Proceedings of MedInfo 2004

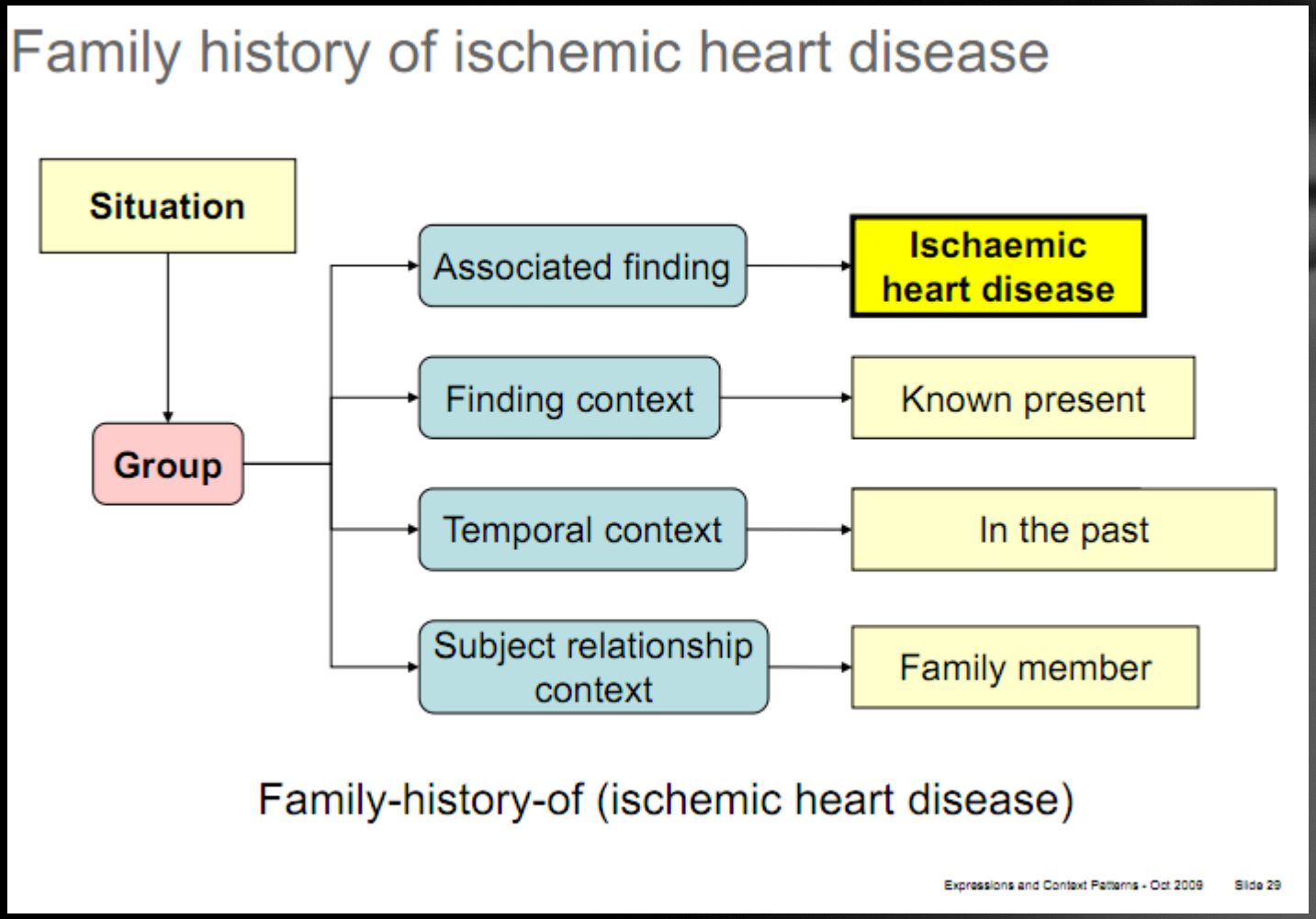
SNOMED-CT – Context Wrappers

Past History



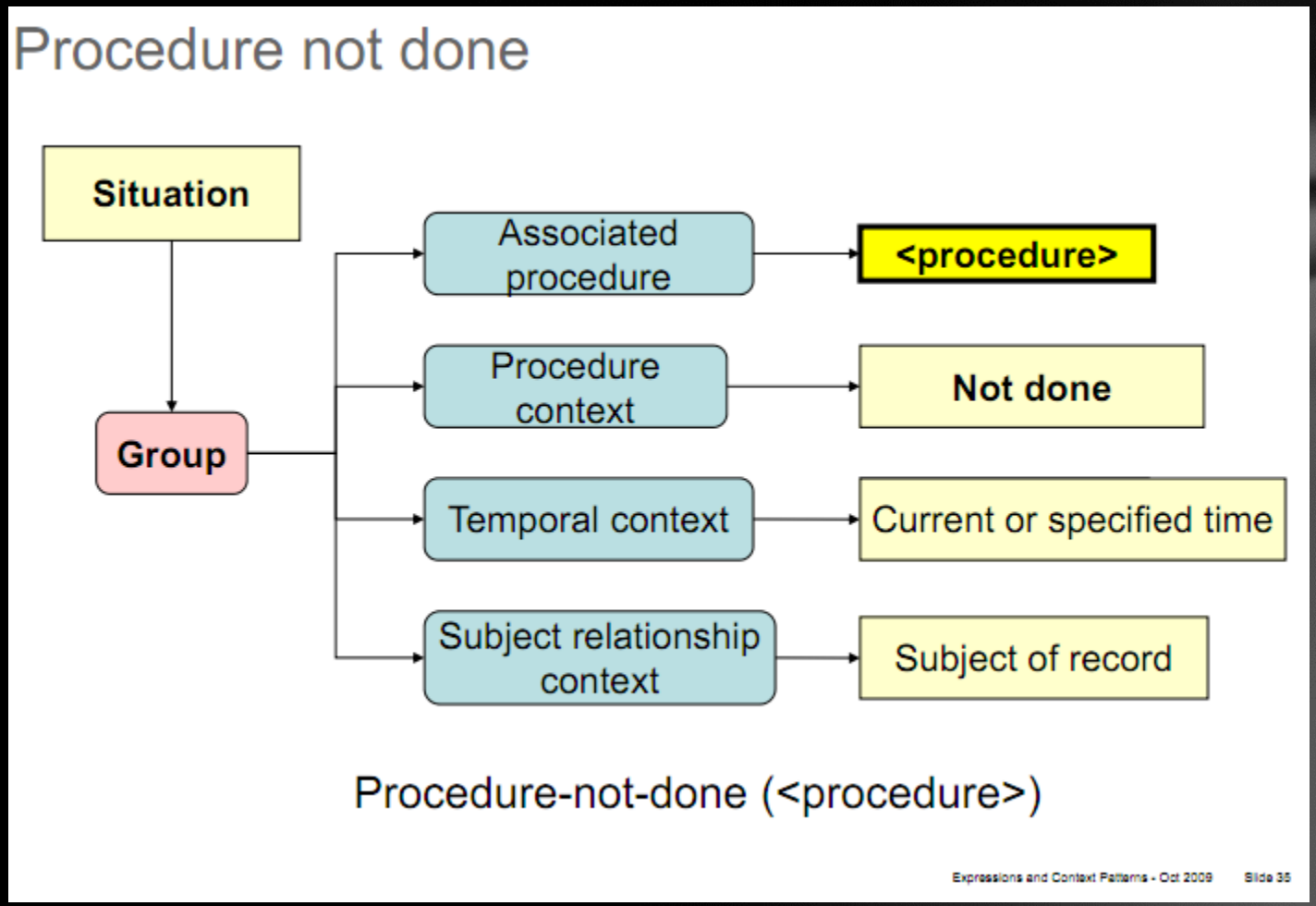
SNOMED-CT - Context Wrappers

Family History



SNOMED-CT - Context Wrappers

Procedure



SNOMED-CT – Context Wrappers

Can be represented using Grammar

Can be represented using Information Model

No clear rules to specify this, need patterns of use

Pivot point options depend on Information Model

HL7 V2 will allow either method

Information Model option requires OBX hierarchy using Sub-ID

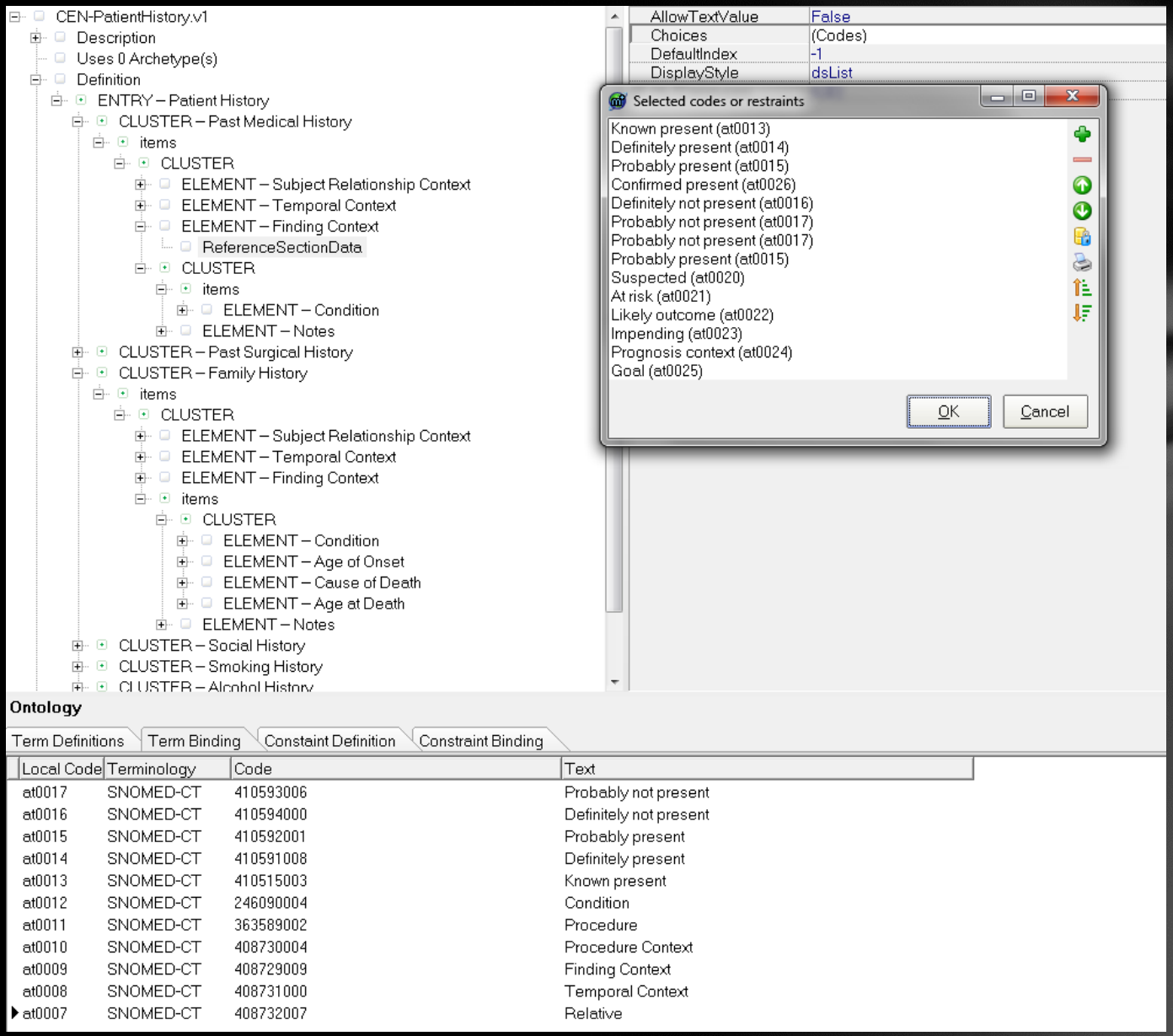
Medical-Objects Position:

SNOMED-CT Grammar for Clinical Findings, Specialisations

Information Model for Context wrappers

Use of Patterns/Templates/Archetypes for Information Model metadata

HL7V2 – Context wrapper in EN13606-2



From the V2 Standard

OBR is defined as a report header, ORF Queries depend on this

Observations are usually ordered and reported as sets (batteries) of many separate observations. Physicians order electrolytes (consisting of sodium, potassium, chloride, bicarbonate) or vitals (consisting of diastolic blood pressure, systolic blood pressure, pulse, and temperature). Moreover, tests that we may think of as single entity, e.g., cardiac echo, usually yield multiple separate measurements, e.g., left ventricular diameter, left atrial diameter, etc. Moreover, observations that are usually reported as text (e.g., the review of systems from the history and physical) can also be considered a set of separately analyzable units (e.g., cardiac history, pulmonary history, genito-urinary history, etc.). We strongly suggest that all text clinical reports be broken down into such separate analyzable entities and that these individual entities be transmitted as separate OBX segments. Because many attributes of a set of observations taken at one time will be identical, one OBR segment serves as a header for the report and carries the information that applies to all of the individual observations in the set. In the case of ordered observations, the OBR segment is a "turn-around document" like the manual request forms it replaces. It carries information about the order to the producing service; a copy of the OBR with additional fields completed is returned with the observations to the requesting service.

Not all observations are preceded by an order. However, all observations whether explicitly ordered or initiated without an order are reported with an OBR segment as the report header.

The OBR segment provides information that applies to all of the observations that follow. It includes a field that identifies a particular battery (or panel or set) of observations (e.g., electrolytes, vital signs or Admission H&P). For

OBX Hierarchy with SubID

Uses "Dotted" Sub-ID (OBX-4)

- Examples of this in existing standards

Allows extensive nesting of OBX segments

- Permits efficient sparse tree algorithms
- Permits reordering of OBX segments for display purposes

Backward compatible

Can be used wherever a repeating OBX group found

- Orders, medication, vaccination messages

Complexity only limited by field length restrictions

Used in trials of VMR in Australia

Used for lab reporting in trial sites in Australia

Can be combined with Metadata specifications

- Creates DCM capable systems
- EN 13606-2 used in trial sites
- Used to transmit VMR in trial sites

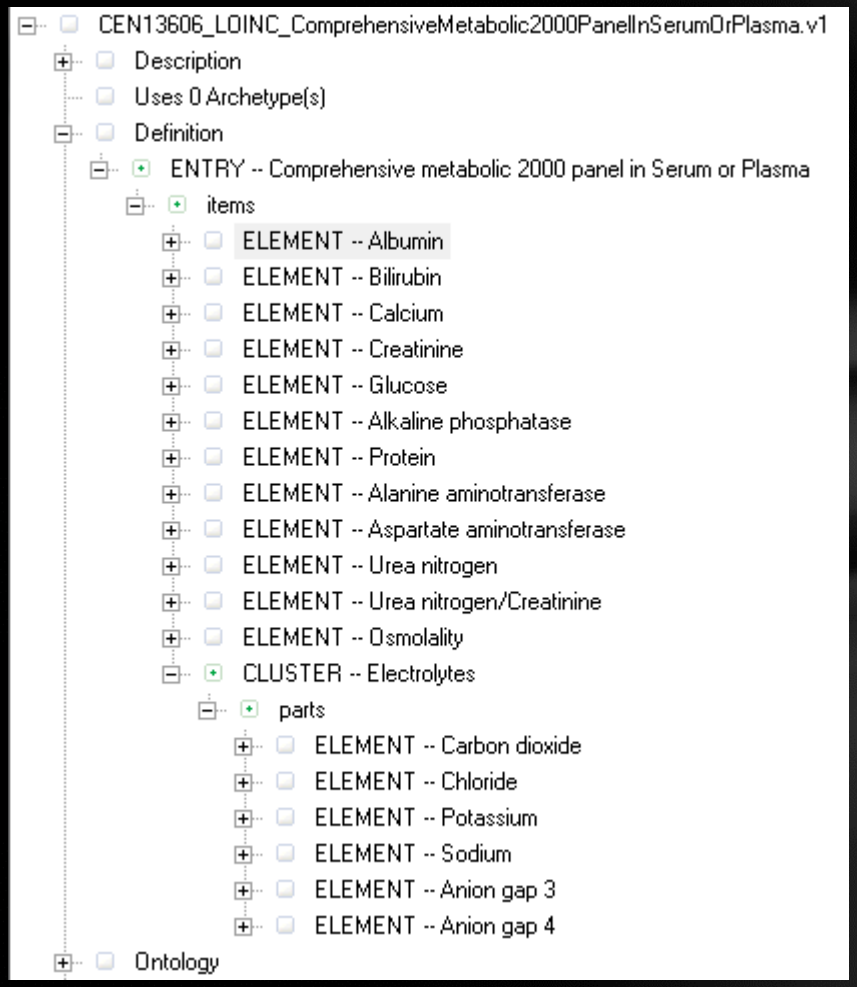
OBX Hierarchy – Chapter 7

The text under *OBX-5-observation value* provides guidance about dealing with two OBXs with the same observation ID and observation sub IDs. They are sent and replaced as a unit. However, some systems will take this to mean that the set of OBXs is to be combined into one composite observation in the receiving system. We suggest the use of a dot and a string (similar to the Dewey Decimal system) when users wish to distinguish each of the repeats within one type, or results within a cell for editing and correction purposes. Using this system, *Figure 7-7* would become *7-8*. If there are cases where such nesting occurs at even deeper levels, this approach could be extended.

Figure 7-8. Example of sub-identifier usage

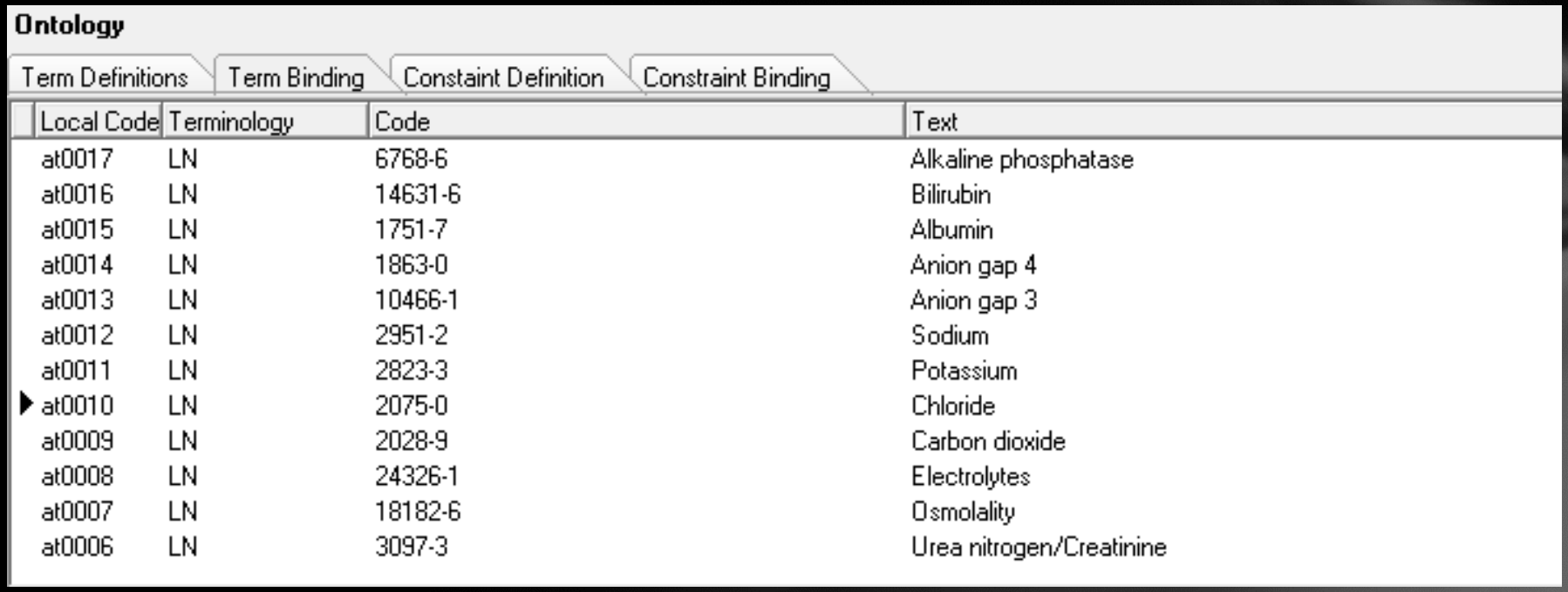
```
OBX|1|CE|880304&ANT|1|T57000^GALLBLADDER^SNM...
OBX|2|TX|880304&GDT|1|THIS IS A NORMAL GALL BLADDER...
OBX|3|TX|880304&MDT|1|MICROSCOPIC EXAMINATION SHOWS HISTOLOGICALLY
NORMAL GALLBLADDER TISSUE...
OBX|4|CE|880304&IMP|1|M-00100^NML^SNM...
OBX|5|CE|880304&ANT|2|T57000^APPENDIX^SNM...
OBX|6|TX|880304&GDT|2|THIS IS A RED, INFLAMED APPENDIX...
OBX|7|TX|880304&MDT|2|INFLAMMATION WITH MANY PUS CELLS-ACUTE INFLAMMATION...
OBX|8|CE|880304&IMP|2.1|M-40000^INFLAMMATION NOS^SNM...
OBX|9|CE|880304&IMP|2.2|M-30280^FECALITH^SNM...
```

Example using LOINC Template



LOINC panel as ISO 13606-2 archetype

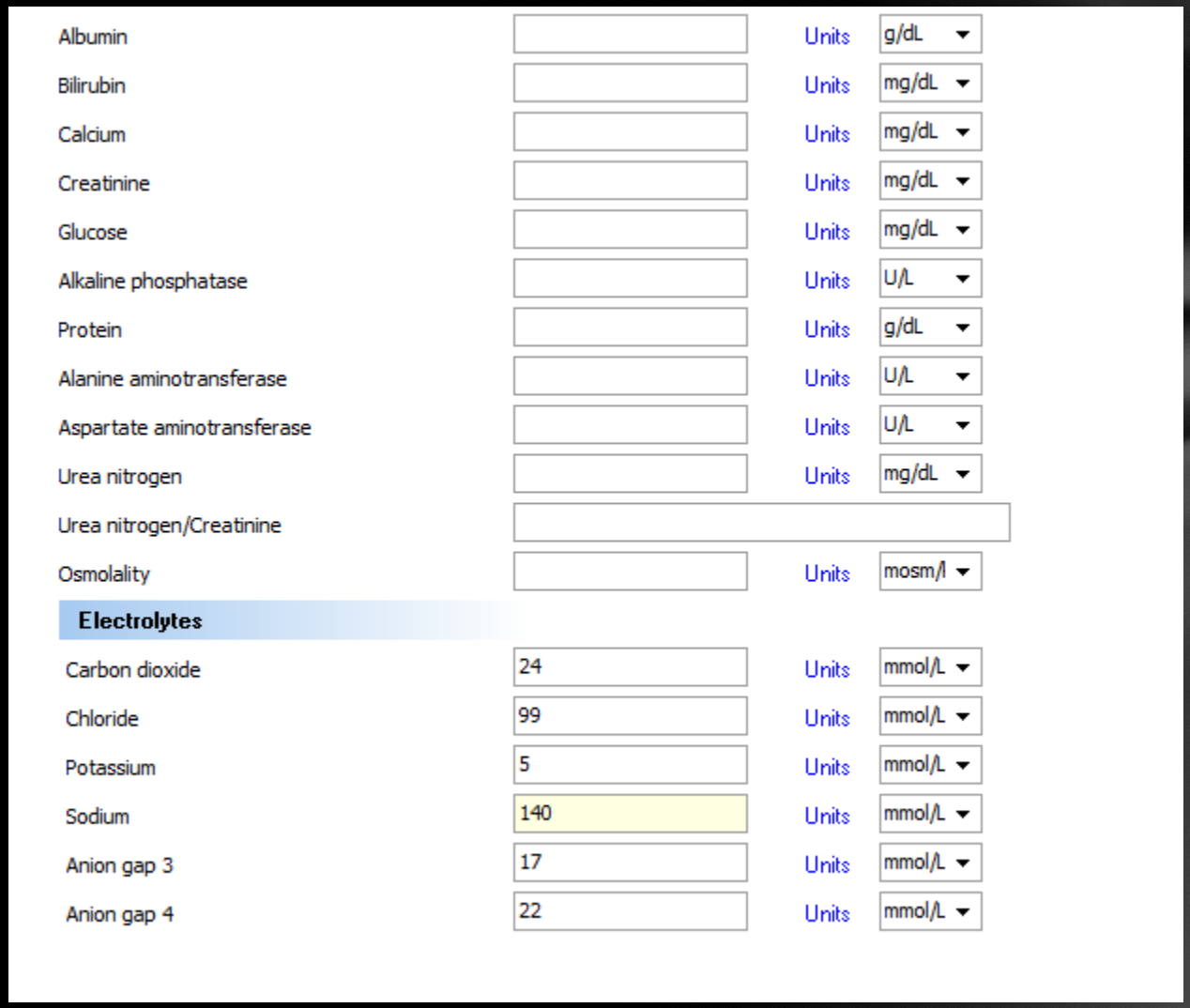
Terminology Binding



Local Code	Terminology	Code	Text
at0017	LN	6768-6	Alkaline phosphatase
at0016	LN	14631-6	Bilirubin
at0015	LN	1751-7	Albumin
at0014	LN	1863-0	Anion gap 4
at0013	LN	10466-1	Anion gap 3
at0012	LN	2951-2	Sodium
at0011	LN	2823-3	Potassium
at0010	LN	2075-0	Chloride
at0009	LN	2028-9	Carbon dioxide
at0008	LN	24326-1	Electrolytes
at0007	LN	18182-6	Osmolality
at0006	LN	3097-3	Urea nitrogen/Creatinine

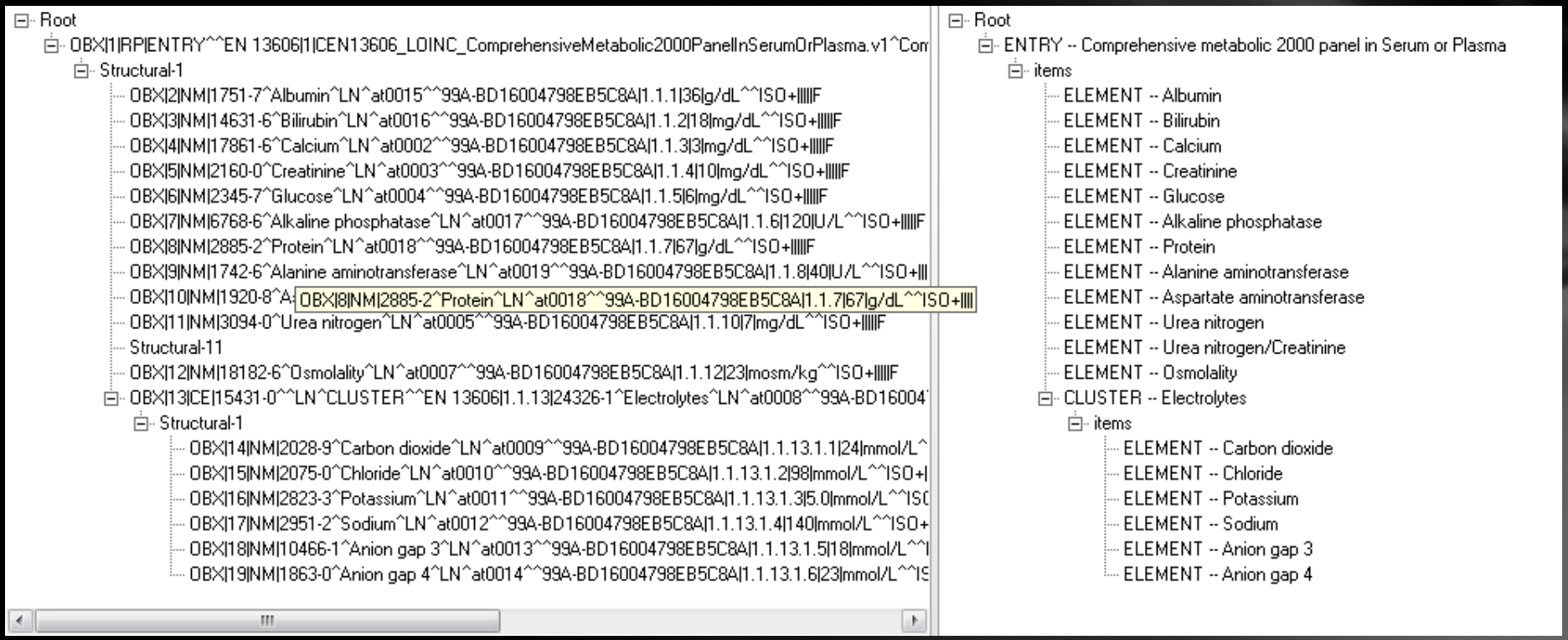
Can Bind to Multiple Terminologies

Allows automated editing



Albumin		Units	g/dL
Bilirubin		Units	mg/dL
Calcium		Units	mg/dL
Creatinine		Units	mg/dL
Glucose		Units	mg/dL
Alkaline phosphatase		Units	U/L
Protein		Units	g/dL
Alanine aminotransferase		Units	U/L
Aspartate aminotransferase		Units	U/L
Urea nitrogen		Units	mg/dL
Urea nitrogen/Creatinine			
Osmolality		Units	mosm/l
Electrolytes			
Carbon dioxide	24	Units	mmol/L
Chloride	99	Units	mmol/L
Potassium	5	Units	mmol/L
Sodium	140	Units	mmol/L
Anion gap 3	17	Units	mmol/L
Anion gap 4	22	Units	mmol/L

OBX Sub-ID creates hierarchy



The OBX-4 mirrors the template hierarchy
Nodes that are unvalued are omitted
OBX used as Section Headers
A RP Header OBX specifies the name of the Template

OBX Section Headers

Primarily for Human Display

ST or CE data types

Name=Value

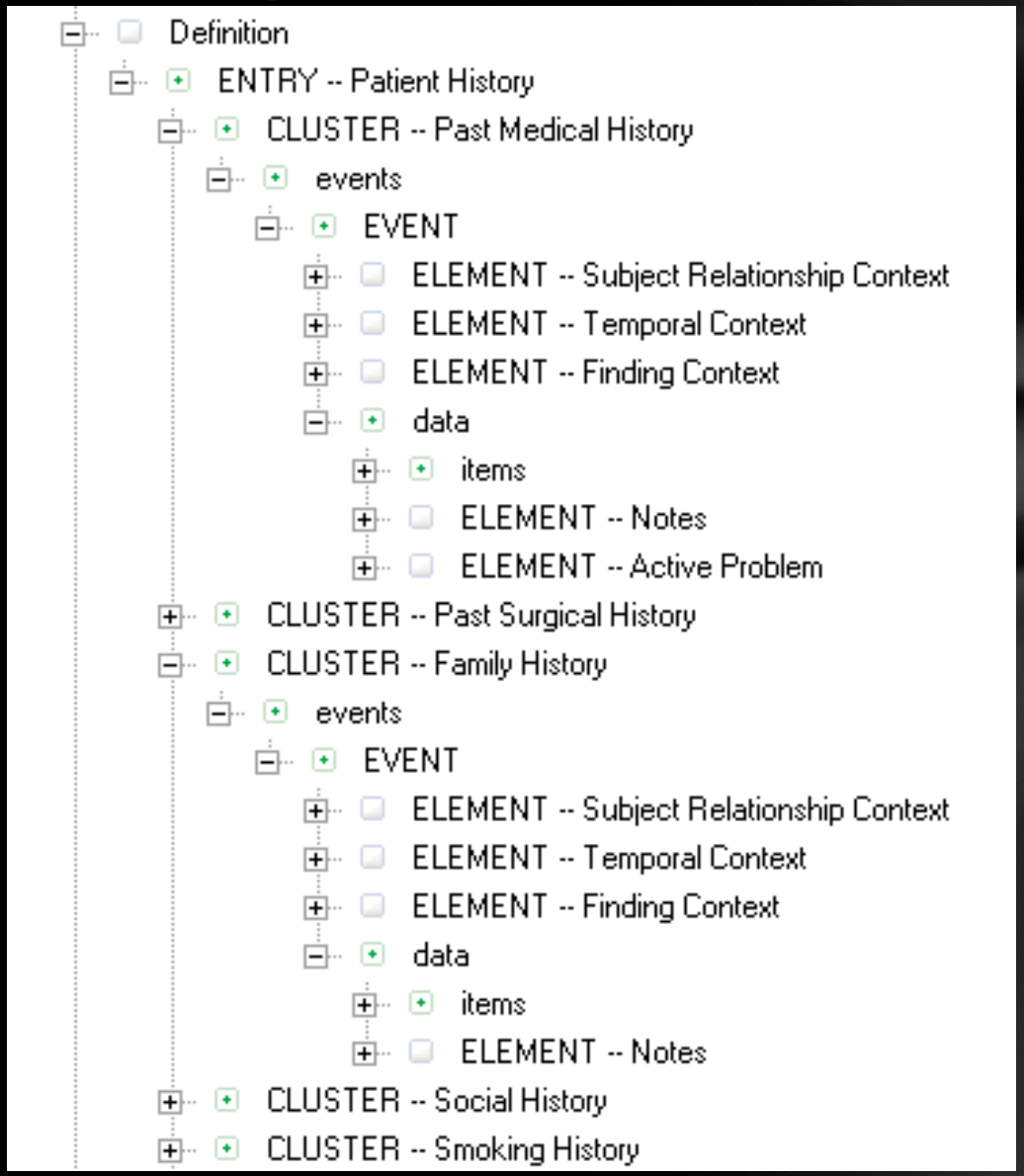
- Section Header = Name of Section Header
- Ideally should have specific LOINC code

OBX|13|CE|15431-0^^LN^CLUSTER^^EN 13606|1.1.13|24326-1^Electrolytes^LN

Currently using LOINC comment code and EN13606 Node name
This suppressing display of OBX-3 in Australian Implementations

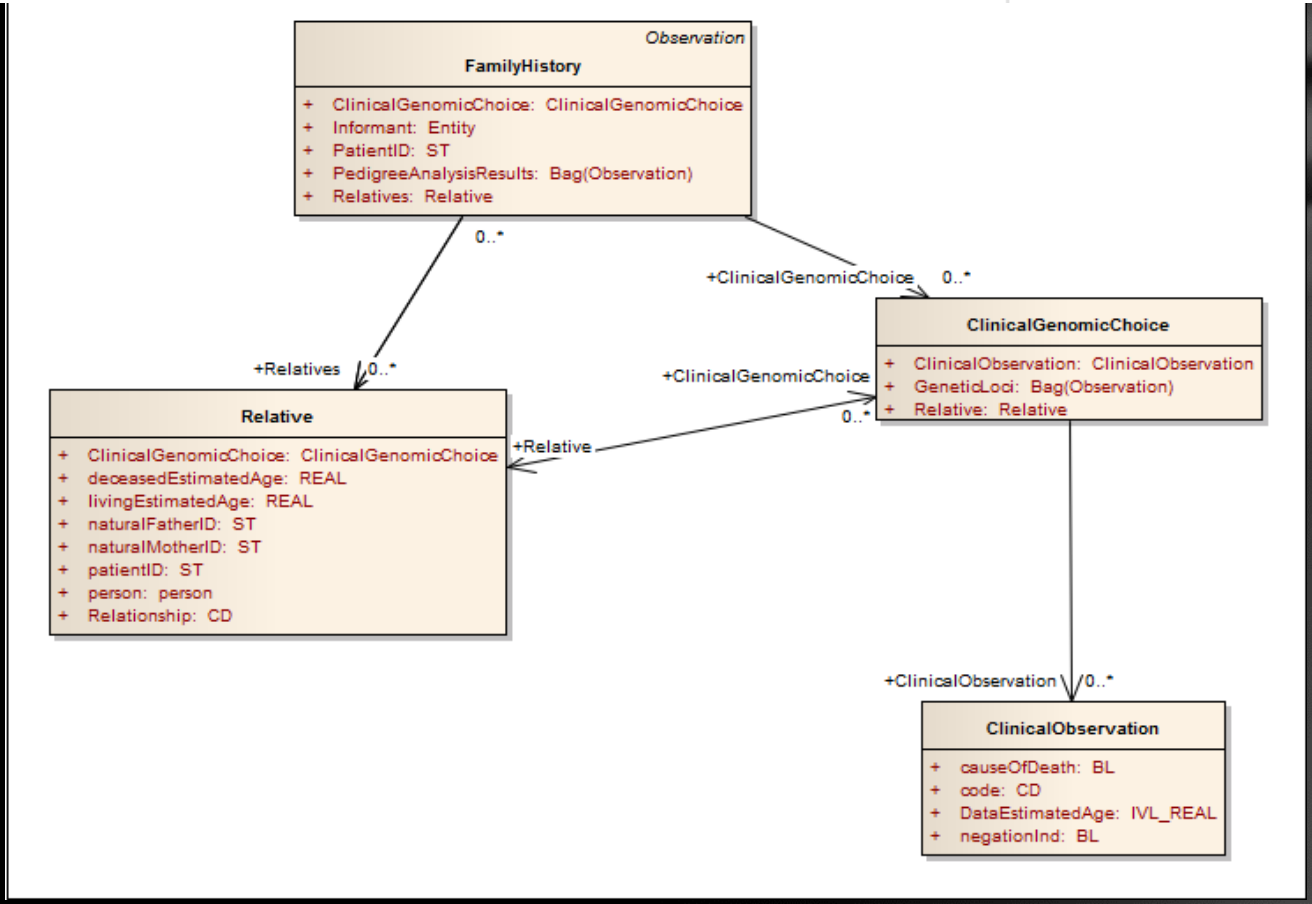
In this example an OBR could be used to create 2 separate documents
In more complex examples clearly a single document
In complex models can be 10-20 section headers

VMR in HL7 V2


Definition
ENTRY -- Patient History
CLUSTER -- Past Medical History
events
EVENT
ELEMENT -- Subject Relationship Context
ELEMENT -- Temporal Context
ELEMENT -- Finding Context
data
items
ELEMENT -- Notes
ELEMENT -- Active Problem
CLUSTER -- Past Surgical History
CLUSTER -- Family History
events
EVENT
ELEMENT -- Subject Relationship Context
ELEMENT -- Temporal Context
ELEMENT -- Finding Context
data
items
ELEMENT -- Notes
CLUSTER -- Social History
CLUSTER -- Smoking History

Allows Gello based CDS in V2

```
1  Let IBD: CodedValue = Factory.CodedValue('24526004', 'SNOMED-CT') --IBD
2  Let Colitis: CodedValue = Factory.Codedvalue('64226004', 'SNOMED-CT') --Colitis
3
4  Let ColitisCount: Integer = FamilyHistory.Relative -> Select(x |
5                  (x.ClinicalGenomicChoice.clinicalObservation ->Select(code.implies(Colitis)or code.implies(IBD)).cardinality() > 0)
6                  and x.LivingEstimatedAge <= 20).cardinality()
7
8  ColitisCount > 0
```



Family History data

```
OBX|10|CE|8262-8^^LN^CLUSTER^^EN 13606|1.3|^Family History^^at0004^^99A-7B3963A353FFB01C||||||F
    OBX|11|CE|408732007^Subject Relationship Context^SNOMED-CT|1.3.1.1.1.1|66839005^Father^SNOMED-CT||||||F
        OBX|12|CE|246090004^^SNOMED-CT|1.3.1.1.1.4.1.1|38341003^Hypertensive disorder^SNOMED-CT||||||F
      OBX|13|CE|21984-0^Cause of Death^LN^at0064^^99A-7B3963A353FFB01C|1.3.1.1.1.4.1.3|64100000^False^SNOMED-CT||||||F
    OBX|14|CE|408732007^Subject Relationship Context^SNOMED-CT|1.3.1.1.2.1|72705000^Mother^SNOMED-CT||||||F
        OBX|15|CE|246090004^^SNOMED-CT|1.3.1.1.2.4.1.1|64766004^Ulcerative colitis^SNOMED-CT||||||F
      OBX|16|NM|30972-4^Age of Onset^LN^at0063^^99A-7B3963A353FFB01C|1.3.1.1.2.4.1.2|20|yrs^^ISO+|||||F
      OBX|17|CE|21984-0^Cause of Death^LN^at0064^^99A-7B3963A353FFB01C|1.3.1.1.2.4.1.3|64100000^False^SNOMED-CT||||||F
      OBX|18|FT|^Notes^^at0006^^99A-7B3963A353FFB01C|1.3.1.1.2.4.2|Colectomy at 27\.br\||||||F
```

Can represent Complex models in V2

- Described by Template
- Only data that differs needs to be in message
  - Allows default values
- V3 Pedigree model could be duplicated

Models can be used in CDA

- If use COMPONENT based ACT relationships

Alternative Specification Format

	A	B	C	D	E	F	G	H
1	DISPLAYNAME	LOCALCODE	OCCURENCES	DATATYPE	V2VALUETYPE	SUBID	LOINC	SNOMED
2	Patient History	at0000	0..1	ENTRY	RP	<root>		
3	Past Medical History	at0002	0..1	SECTION	CE	<root>.1		
4	Subject Relationship Context	at0007	0..1	CODEDVALUE	CE	<root>.1.1.1.RepeatOf[EVENT].1		408732007
5	Temporal Context	at0008	0..1	CODEDVALUE	CE	<root>.1.1.1.RepeatOf[EVENT].2		408731000
6	Finding Context	at0009	0..1	CODEDVALUE	CE	<root>.1.1.1.RepeatOf[EVENT].3		408729009
7		at0012	0..1	CODEDVALUE	CE	<root>.1.1.1.RepeatOf[EVENT].4.1.1		246090004
8	Notes	at0006	0..1	STRING	ST	<root>.1.1.1.RepeatOf[EVENT].4.2		
9	Past Surgical History	at0003	0..1	SECTION	CE	<root>.2		
10	Subject Relationship Context	at0007	1..1	CODEDVALUE	CE	<root>.2.1.1.RepeatOf[EVENT].1		408732007
11	Temporal Context	at0008	1..1	CODEDVALUE	CE	<root>.2.1.1.RepeatOf[EVENT].2		408731000
12	Procedure Context	at0010	1..1	CODEDVALUE	CE	<root>.2.1.1.RepeatOf[EVENT].3		408730004
13		at0011	0..1	CODEDVALUE	CE	<root>.2.1.1.RepeatOf[EVENT].4.1.1		363589002
14	Notes	at0006	0..1	STRING	ST	<root>.2.1.1.RepeatOf[EVENT].4.2		
15	Family History	at0004	0..1	SECTION	CE	<root>.3		
16	Subject Relationship Context	at0007	1..1	CODEDVALUE	CE	<root>.3.1.1.RepeatOf[EVENT].1		408732007
17	Temporal Context	at0008	1..1	CODEDVALUE	CE	<root>.3.1.1.RepeatOf[EVENT].2		408731000
18	Finding Context	at0009	1..1	CODEDVALUE	CE	<root>.3.1.1.RepeatOf[EVENT].3		408729009
19		at0012	0..1	CODEDVALUE	CE	<root>.3.1.1.RepeatOf[EVENT].4.1.1		246090004
20	Notes	at0006	0..1	STRING	ST	<root>.3.1.1.RepeatOf[EVENT].4.2		
21	Social History	at0005	0..1	SECTION	CE	<root>.4		
22	Notes	at0006	0..1	STRING	ST	<root>.4.1.1		
23	Smoking History	at0047	0..1	SECTION	CE	<root>.5		
24	Ever Smoker	at0050	0..1	BOOLEAN	ST	<root>.5.1.1		
25	Current tobacco intake	at0048	0..1	PHYSICALQUANTITY	NM	<root>.5.1.2.1		
26	Time Ceased	at0049	0..1	PHYSICALQUANTITY	NM	<root>.5.1.2.2		

Can represent Complex models in V2

- Described by Template – Can use spread sheet formats
- Hierarchy specified using OBX-4 Sub-ID
- Allows representation of SNOMED-CT context models
- Default values need not be transmitted in message

Summary

SNOMED-CT/Coded Values easily used in HL7 V2

Software Support for OBX with Coded values as OBX value type patchy currently

HL7V2 coded value Data Types enhanced in later versions

- Need to build data type extensions into current software

SNOMED-CT Grammar can be used in V2 Data types

- Need to look at field length issues in software
- Use of Grammar requires inferencing eg GELLO/Terminology Services

Templating of V2 allows Hierarchies to be constructed

- Archetypes can be used for design
- Simpler artifacts eg Spreadsheets for implementations

Implementations need to better support enhancements to enable Decision Support