HIMSS ASIAPAC12 CONFERENCE

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MARINA BAY SANDS, SINGAPORE

transforming healthcare through IT™

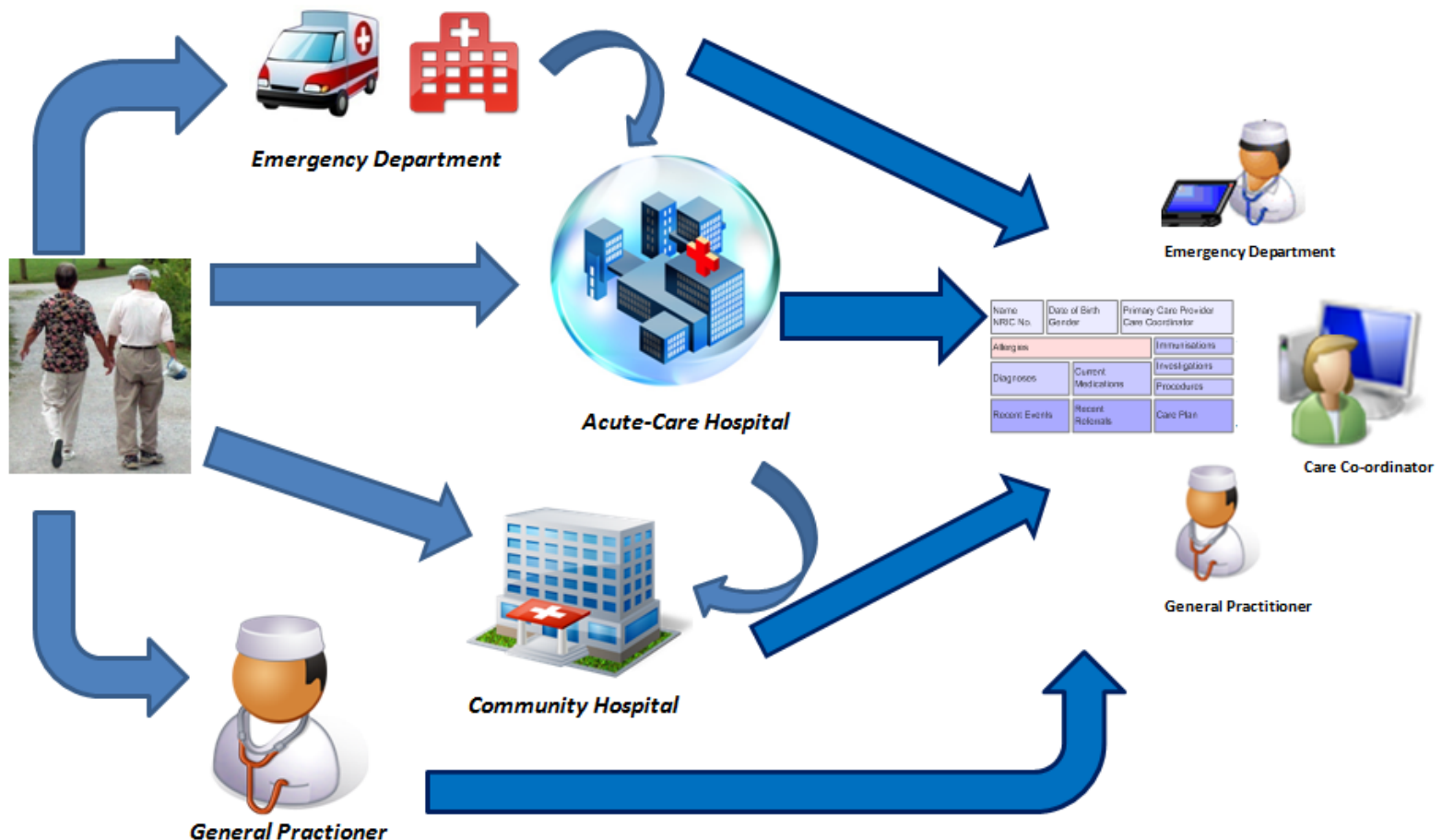# USING HL7 V2 WITHIN A FRAMEWORK FOR SEMANTIC INTEROPERABILITY

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Interoperability Challenges

- Strategic vision: patients moving seamlessly across the healthcare system, receiving coordinated patient-centric care at the most appropriate settings

- Lack of message standardisation in Singapore has hindered information sharing between clusters, sectors and facilities
  - Many variations in local HL7 v2 message profiles
  - Widespread use of locally defined Z-segments/fields
  - Lack of conformance quality testing
  - Disconnected terminology sets, which differ in their degree of pre-coordination due to differing local interfaces and structures

- Each system may need to support dozens of interfaces

Information Flows With The Patient

Emergency Department

Acute-Care Hospital

Community Hospital

General Practioner

Emergency Department

Care Co-ordinator

General Practitioner

Different Information Models

E.g., "Severe osteoarthritis of the left knee" diagnosis

Data Source1

GP

Prob/Dx Entry

Prob/Dx Osteoarthritis

Severity
- Mild
- Moderate
- Severe

Location Knee Joint

Side
- ☑ Left
- ☐ Right

OK   Cancel

Data Source2

Polyclinic

Diagnosis Entry

Diagnosis
Osteoarthritis of the left knee

Degree
Severe

- Minimal
- Mild
- Moderate
- Severe
- Very severe

OK   Cancel

Data Source3

RH

Problem/Diagnosis Entry

Problem/Diagnosis
Severe Osteoarthritis of the left knee

OK   Cancel

eHealth Data Goals

- Improve availability, reliability and quality of shared healthcare data

- Safe exchange of messages and documents

- Safe interpretation, processing and reasoning over shared data

- Ability to apply decision support rules over shared data

- Meaningful query over data from multiple sources

- Ability to persist shared data in native data stores of receiving clinical systems (bi-directional semantic interoperability)

Communication Challenges
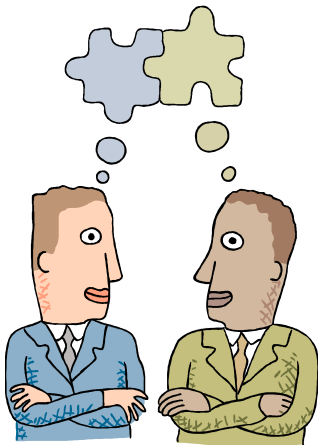
- 1-1 verbal communication
  - Known target audience
  - Easy to agree on common understanding
  - Clarification

- Many to Many?

- Electronic communication
  - Unknown audience
  - Common understanding?
  - Clarification?

- Many to Many?

Singapore's National Data Standards

Establishing a suite of Standards that are:

- **Clinically-driven**
- **Easy to Use**
- **Internationally recognised**

to ensure clinical data included in the NEHR can be:

✓ Shared and exchanged safely and reliably

✓ Relied on for the monitoring and care of patients

✓ Used meaningfully for secondary purposes including the production of clinical knowledge

Global Standards Engagements

- CIMI (Clinical Information Modelling Initaitive)
- HL7 (Health Level Seven)
- IHTSDO (International Health Terminology Standards Development Organization)
- ISO TC215 on Health Informatics

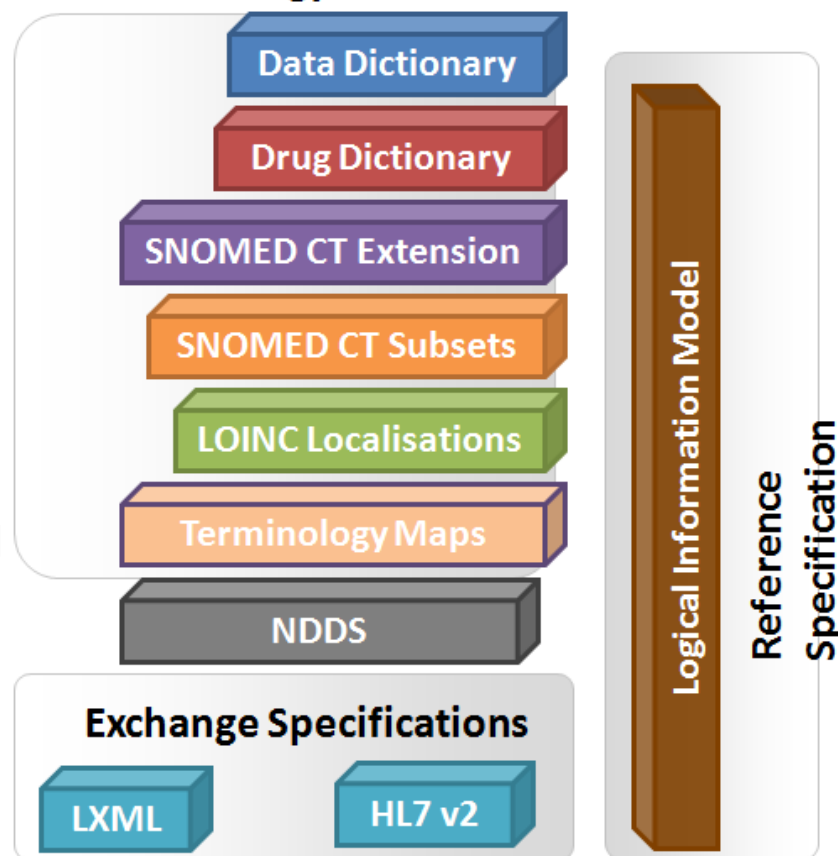**Standards also provide a platform for long term semantic interoperability and research informatics**

Guiding Principles to Enable Information Sharing

Clinically-driven
- Clinician participation is key in increasing semantic interoperability and improving clinical content of the stored data

- Increases familiarity and helps clinicians provide valuable inputs to ensure clinical context

Easy to use
- Reduces ambiguity and facilitates greater collaboration (*and participation*) amongst the clinical community, clinical informatics and the technical community

Internationally recognised
- International recognition for a standard would mean wider adoption by the mainstream international vendors — reducing vendor lock-in

- This will lower the total cost of ownership for any organisation (such as the MOHH), and will tap into a larger pool of skilled workforce — reducing business continuity risks

- Enables interoperable exchange of detailed clinical models, while being able to re-use existing international best-practices (e.g. CIMI)

Semantically interoperable
- Implies that new data exchanged can be combined seamlessly with existing data and processed homogeneously

- Combination of clinical data from local and external systems will then be processed identically and collectively without any loss of meaning

- Semantic interoperability will therefore help enhance clinical safety and quality of care

Standards Products

- **Diagnosis** - SNOMED CT and Singapore Extension (SE)
- **Drugs** - Singapore Drug Dictionary (SDD)
- **Allergic Reactions**– SNOMED CT + SE
- **Allergens** - SNOMED CT + SDD
- **Laboratory Results** – LOINC
- **Data Dictionary** – MOHH Data Dictionary
- **Procedures** - TBD
- **Reason for visit** - SNOMED CT
- **Symptoms and Problems** - SNOMED CT and Singapore Extension
- **Laboratory Reports** – Smart SNOMED CT
- **Laboratory Orders** – SNOMED CT
- **Radiology Orders** - SNOMED CT

Terminology Products

- Data Dictionary
- Drug Dictionary
- SNOMED CT Extension
- SNOMED CT Subsets
- LOINC Localisations
- Terminology Maps
- NDDS

Exchange Specifications

- LXML
- HL7 v2

Logical Information Model

Reference Specification

Singapore Logical Information Model (LIM)

- An implementation-independent information model for shared healthcare data
- Developed as a set of reusable clinical models or 'archetypes'
  - E.g. 'Problem/Diagnosis', 'Pharmacy Order', 'Observation'
- The LIM provides a conceptual view of:
  - Domain entities (e.g. patient, clinician, medication item, lab result)
  - Their attributes (e.g. name, identifier, active ingredient, dosage form)
  - Relationships and associations (e.g. is-a, consults, refers, admits)
  - Constraints (e.g. optionality, value domains)
- Based on profiles of ISO 13606-1 and ISO 21090
- Clinical models are combined and constrained to form use-case specific 'templates'
  - Mappings from existing HL7 v2 message profiles to LIM
  - Represent elements and constraints to form national message type standards

The LIM for Validation

LIM ID	LIM Name	LIM Cardinality	LIM Definition	LIM Example (for Exchange)	LIM Example (for Display)
	Laboratory Test Item	**1**	**A class describing the laboratory test that was performed.**		
	Test Name	1	The name of the laboratory test within a panel of tests.	("xxx", "LDH measurement") ("xxx", "Blood sodium measurement")	"LDH measurement" "Blood sodium measurement"
	Sequence Number	0..1	A number that identifies and sequences this laboratory test item within a given panel.	"1" "2"	"1" "2"
	Additional Description	0..1	A descriptor used in combination with the Test Name to fully define the description of the laboratory test.		
	POCT Indicator	0..1	The POCT (Point-of-care Testing) indicator at the laboratory test item level.	("xx, "Point of Care Test")	"Point of Care Test"
	Type	0..1	The type of the test.		

LIM Development Process
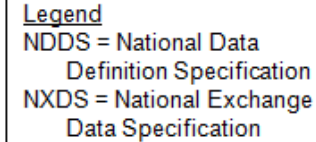
LIM Archetypes & Templates

S/N	Worksheets	Type	ADT	Lab	Radiology	Pharmacy Order (PO)	Pharmacy Dispense (PD)	Referral	ACIDS Phase 1
P1-P17	Participant	Participation	✓	✓	✓	✓	✓	✓	✓
M1	Investigation Message	Message		✓	✓				
M2	Patient Event Message	Message	✓						✓
M3	Pharmacy Message	Message				✓	✓		
X1	Investigation Extract	EHR Extract		✓	✓				
X2	Patient Event Extract	EHR Extract	✓						✓
X3	Pharmacy Extract	EHR Extract				✓	✓		
X5	Referral Extract	EHR Extract						✓	
C1	Investigation Composition	Composition		✓	✓				
C2	Patient Event Composition	Composition	✓					✓	✓
C3	Pharmacy Composition	Composition				✓	✓		
C11	Referral Application	Composition						✓	
C12	Attachment	Composition						✓	
S1	Problem Diagnosis List	Section	✓					✓	✓
S2	Medication List	Section						✓	✓
E1	Patient Event Context	Entry	✓	✓	✓	✓	✓	✓	✓
E2	Composition Information	Entry	✓	✓	✓	✓	✓	✓	✓
E3	Problem Diagnosis	Entry	✓					✓	✓
E4	Pharmacy Activity	Entry							
E5	Pharmacy Order	Entry				✓	✓		✓
E6	Pharmacy Dispense	Entry					✓		
E7	Investigation Order	Entry		✓	✓				
E8	Investigation	Entry		✓	✓			✓	
E9	Procedure	Entry						✓	
CL1	Pharmacy Item	Cluster				✓	✓	✓	
CL2	Investigation Test Item	Cluster		✓	✓				
R1	Data Types	Reference Model	✓	✓	✓	✓	✓	✓	✓

HL7 v2 Exchange Format

- Key Design Principles
  - Based on LIM to support semantic interoperability and reuse of data structure and terminology binding
  - Structured OBX segments are used to represent the LIM hierarchical structure that cannot be mapped to other HL7 v2 segments
  - Obeys HL7 v2 encoding rules and messaging specifications
    - Support existing health care message infrastructure to reduce cost
  - Exclude US-centric elements and Z segments

Leaf & Non-leaf Elements

LIM ID					LIM Name
CL2					**INVESTIGATION TEST ITEM**
Record Keeping Content					
Clinical Content					
	CL2.14				Investigation Test Item
	CL2.15				Investigation Test Result
		CL2.15.1			Test Result Value
		CL2.15.2			Test Result Value Type
		CL2.15.3			Abnormal Indicator
		CL2.14.5			Reference Range Set
			CL2.14.5.1		Reference Range Set Name
			CL2.14.5.2		Reference Range Summary
			CL2.14.5.3		Reference Range Item
				CL2.14.5.3.1	Reference Range Criteria
				CL2.14.5.3.2	Reference Range Value
				CL2.14.5.3.3	Reference Range Interpretation Code
		CL2.15.5			Remarks
		CL2.15.6			Test Result
	CL2.16				Investigation Test Statuses
		CL2.16.1			Test Result Status

Leaf Elements

Non-leaf Elements

OBX||CNE|13342123^CLUSTER^SCT|1.1.3.1.1|^Reference Range Set^SCT||||||F

OBX||CNE|13343123^CLUSTER^SCT|1.1.3.1.2.1|^Reference Range Item^SCT||||||F

OBX||SN|^Reference Range Value^SCT|1.1.3.1.2.1.2|^3.50^-^25.00 ||||||F

OBX||CWE|^Reference Range Interpretation Code^SCT|1.1.3.1.2.1.3|^normal^SCT||||||F

OBX||CNE|13342123^CLUSTER^SCT|1.1.3.1.2.2|^Reference Range Item^SCT||||||F

OBX||SN|^Reference Range Value^SCT|1.1.3.1.2.2.2|>^25.00||||||F

OBX||CWE|^Reference Range Interpretation Code^SCT|1.1.3.1.2.2.3|^indicative of macroalbuminuria and probably overt proteinuria^SCT||||||F

Rules for Populating OBX Segment (Leaf Elements)

Field Sequence	Element Name	Data Type	Sample Value	Description
1	Set ID	SI	39	Set ID should increment as usual for each OBX.
2	Value Type	ID	TS	Variable data type. Select data type according to Table 6 – ISO21090 to HL7 v2 Datatype mapping for use in OBX segments
3	Observation Identifier	CE	E1.24.4^Patient Movement DateTime^MOHH LIM ID^at0025^^99A-C6D6E6D018DF1B7B	SNOMED-CT or LOINC value as the primary CE identifier to denote that this OBX represents a HL7v2 section.
3.1	Identifier	ST	E1.24.4	MOHH MAPPING column value from archetype spreadsheet
3.2	Text	ST	Patient Movement DateTime	DISPLAYNAME column value from archetype spreadsheet
3.3	Name of Coding System	ST	MOHH LIM ID	
3.4	Alternate Identifier	ST	at0025	LOCAL CODE column value from archetype spreadsheet
3.5	Alternate Text	ST		
3.6	Name of alternate coding system	ST	99A-C6D6E6D018DF1B7B	Unique archetype identifier eg. hash or OID representing the archetype. This is taken from 5.2.2 of Table 2 - OBX Field sequence for ENTRY level.
4	Observation Sub-ID	ST	2.1.2.1.4	Substitute the root sub id used by the ENTRY into the sub id from the spreadsheet
5	Observation Value	"V2 Value Type" column datatype	201009050700	Encode the LIM ISO data element using the ISO 21090 to HL7v2.3.1 mapping from section 4.2 Data type mapping between ISO21090 and HL7v2.3.1.
6	Units	CE	x10*12/L^^ISO+	ISO+ units; used when ISO 21090 PQs are represented as HL7 v2 NMs
11	Observation Result Status	ID	"F"	"F" for final result, "C" for correction etc. See HL7 table for full details.

Rules for Populating OBX Segment (Non-leaf Elements)*

Field Seq	Element Name	Data Type	Sample Value	Description
1	Set ID	SI	38	Set ID should increment as usual for each OBX.
2	Value Type	ID	CNE	Fixed data type, always CNE.
3	Observation Identifier	CNE	15431-0 ^^LN^CLUSTER^^EN 13606	SNOMED-CT or LOINC value as the primary CE identifier to denote that this OBX represents a HL7v2 section.
3.1	Identifier	ST	15431-0	Use the LOINC column value or Use the SNOMED-CT column value
3.2	Text	ST		
3.3	Name of Coding System	ST	LN	Use "LN" if the LOINC identifier used, or use "SCT" if the SNOMED-CT identifier was used
3.4	Alternate Identifier	ST	CLUSTER	
3.5	Alternate Text	ST		
3.6	Name of alternate coding system	ST	EN 13606	
4	Observation Sub-ID	ST	2.1.2	Substitute the root sub id used by the ENTRY into the sub id from the spreadsheet
5	Observation Value	CNE	E1.24^Patient Event Dates^MOHH LIM ID^at0011^^99A-C6D6E6D018DF1B7B	This is a CNE datatype
5.1	Identifier	ST	E1.24	MOHH Mapping column value Eg. "E1.24" from archetype spreadsheet
5.2	Text	ST	Patient Event Dates	DISPLAYNAME column value from archetype spreadsheet
5.3	Name of Coding System	ST	"MOHH LIM ID"	
5.4	Alternate Identifier	ST	at0011	LOCAL CODE column value from archetype spreadsheet
5.5	Alternate Text	ST		
5.6	Name of alternate coding system	ST	99A-C6D6E6D018DF1B7B	Unique archetype identifier eg. hash or OID representing the archetype. This is taken from 5.2.2 of Table 2 - OBX Field sequence for ENTRY level.
11	Observation Result Status	ID	"F"	"F" for final result, "C" for correction etc. See HL7 table for full details.

*: Slightly different rules apply for ENTRY-level non-leaf elements

Sample HL7 v2 NXDS Message (Lab Results)

```
MSH|^~\&|M1^M1:2.20.2 (Build 3792) [win32-i386]^L|SG Pathology^93732^SG|||20110218101133+1000||ORU^R01|SYNC_XX02181011130-
    7217|P|2.3.1^SGP&&ISO^SG_LR_LXML&&L|||||SGP
PID|1|54678432^^^SG Pathology&93732&SG^FI|100003^^^ABCHospital&7C3E3682-91F6-11D2-8F2C-444553540000&GUID^MR^Demo&0AE5C60C-A510-43B3-
    A509-C57F29B2D368&GUID||TAN^John^^^Mr^^L||19720625|M|||15 Orchard
    Road^^ORCHARD^^^SG^C||6569227441^PRN^PH^^65^^6569227441|||||||||||||||||||N
PV1|1|O||||||1234567U^AMY^TAN^^^DR^^^ABCHospital^L^^^MCR|1234567U^AMY^TAN^^^DR^^^ABCHospital^L^^^MCR|||||||N
ORC|RE|999111^Clinic001^0AE5C60C-A510-43B3-A509-C57F29B2D368^GUID|576587658-1^SG
    Pathology^93732^SG||IP|||||||1234567U^TAN^AMY^^^DR^^^ABCHospital^L^^^MCR
OBR|1|999111^Clinic001^0AE5C60C-A510-43B3-A509-C57F29B2D368^GUID|576587658-1^SG Pathology^93732^SG|26604007^Full Blood
    Count^SCT^CBC^^SG.15454|R|20120216+1000|201202170705+1000||||L||Tired. \E\.br\E\Nil thyroid
    meds.\E\.br\E\DL\E\.br\E\||BLDV&&HL70070|1234567U^AMY^TAN^^^DR^^^ABCHospital^L^^^MCR||||LN=576587658||201202171011+1000||HM|R||^^^
    20120216+1000^^R|||||PC0000000T8&SG Pathology&&&&&&XYZ|||||||^Pregnant:False~^Fasting:True~^Radiotherapy:False~^Hormonal Therapy:False
OBX|1|RP|14412233^ENTRY^SCT|1|CEN.MOHH_Investigation.v1^Investigaton Entry&99A-0B5161146D10925E&L^TX^Octet-stream||||||
OBX|2|CNE|16664221^FUNCTIONAL_ROLE^SCT|1.1|CEN.MOHH_Investigation.v1^Reporting Clinician&99A-0B5161146D10925E&L^TX^Octet-stream||||||F
OBX|3|CNE|E8.20.1^Function^MOHH LIM ID^at0002^^99A-0B5161146D10925E|1.1.1|F0131^Reporting Clinician^MOHH_DD||||||F
OBX|4|EI|E8.20.2^Performer^MOHH LIM ID^at0002^^99A-0B5161146D10925E|1.1.2|0AE5C60C-A510-43B3-A509-C57F29B2D368||||||F
OBX|5|CNE|13342123^CLUSTER^SCT|1.2|CEN.MOHH_Investigation.v1^Investigaton Item&99A-0B5161146D10925E&L^TX^Octet-stream||||||F
OBX|6|RP|E8.22.1^Investigation Name^MOHH LIM ID^at0008^^99A-0B5161146D10925E|1.2.1|718-2^FULL BLOOD COUNT^LN||||||F
OBX|7|CNE|13342123^CLUSTER^SCT|1.2.2.1|CEN.MOHH_Investigation.v1^Investigaton Test Item&99A-0B5161146D10925E&L^TX^Octet-stream||||||F
OBX|8|CNE|CL2.14.1^Test Name^MOHH LIM ID^at0010^^99A-0B5161146D10925E|1.2.2.1.1|1231-2^Haemoglobin^LN||||||F
OBX|9|NM|CL2.15.1^Test Result Value^MOHH LIM ID^at0011^^99A-0B5161146D10925E|1.2.2.1.2|123|g/L^^ISO+|||||F
OBX|10|CNE|13342123^CLUSTER^SCT|1.2.2.2|CEN.MOHH_Investigation.v1^Investigaton Test Item&99A-0B5161146D10925E&L^TX^Octet-stream||||||F
OBX|11|CNE|CL2.14.1^Test Name^MOHH LIM ID^at0010^^99A-0B5161146D10925E|1.2.2.2.1|789-8^Red Cell Count^LN||||||F
OBX|12|NM|CL2.15.1^Test Result Value^MOHH LIM ID^at0011^^99A-0B5161146D10925E|1.2.2.2.2|3.5|x10*12/L^^ISO+|||||F
OBX|13|CNE|13342123^CLUSTER^SCT|1.2.2.3|CEN.MOHH_Investigation.v1^Investigaton Test Item&99A-0B5161146D10925E&L^TX^Octet-stream||||||F
OBX|14|CNE|CL2.14.1^Test Name^MOHH LIM ID^at0010^^99A-0B5161146D10925E|1.2.2.3.1|4544-3^Haematocrit^LN||||||F
OBX|15|NM|CL2.15.1^Test Result Value^MOHH LIM ID^at0011^^99A-0B5161146D10925E|1.2.2.3.2|0.36|L/L^^ISO+|||||F
```

Areas for Future Work

- **Using tooling to accelerate updates to Implementation Guides**
  - Tooling can be used to track various mappings and produce required documentation quickly:
    - Element mappings: NDDS to HL7 v2 NXDS
    - Data type mappings: ISO 21090 to HL7 v2 NXDS
  - Tooling platform to be ready over the period 2012-2013

- **Definition of conformance profiles**
  - Each profile/level will include different validation checks

Conclusion

- We believe that the logical modelling approach based on the LIM in a hybrid protocol environment allows HL7 v2 to be used as part of an architectural solution for semantic interoperability

THANK YOU