Mapping local clinical chemistry code with LOINC

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Abstract

Background: The present time, the Health Information Exchange (HIE) is very important and is needed in every health organization. The usefulness of HIE include; improving the quality of care, medical reimbursement, epidemiological report, resource and human management, management in health insurance, financial management and etc. Health data standard is a major component which has ability to enable the exchanging of data between health organizations. Thailand needs to adopt the standard for laboratory in national level that has potential to allow the semantic interoperability. Thai Health Information Standard Development Center (THIS) is under Health System Research Institute (HSRI) reviewed international standard for laboratory and suggested to use Logical Observation Identifier Name and Codes (LOINC). LOINC is a universal coding system for identifying laboratory and clinical observations. It was developed and was maintained by Regenstrief Institute of USA. LOINC covered almost all the medical laboratory tests and is widely used in many countries and will be use continues to grow globally.

Clinical chemistry test is commonly ordered by physician when patient is needed clinical diagnosis. As a result, studying the scope between LOINC and local clinical chemistry test is necessary to help decision making for LOINC adoption.

Objective: To evaluate the coverage of LOINC to Thai clinical chemistry test in three hospitals.

Method: The clinical laboratory data were obtained from three different locations; 1) Ramathibodi hospital, 2) Siriraj hospital and 3) Chulalongkorn hospital. The Regenstrief LOINC Mapping Assistant (RELMA) was used to map international standard code with local tests by medical technologist.

Results: Local clinical chemistry test data are able to map with LOINC code more than 95% of which, 46.92% is one to one mapping and 48.43% is one to many mapping.

Conclusions and discussions: International standard for medical laboratory (LOINC) has covered clinical chemistry laboratory in all 3 major hospitals. The results showed that more than 95% are able to map. This conclude that LOINC is suitable and practical for clinical chemistry laboratory in Thailand.

Keywords: health data standard, interoperability, LOINC, medical laboratory, RELMA.

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Introduction

HIE is the transmission of health information between health organizations at all level. It is one of important components that can improve the quality of care.[1]

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The need of health data usage is increasing over the past decade, this is not only for healthcare provider but patient and consumer as well. The benefit of HIE also include pooling data for research study, planning health policy, especially continuity of care and patient safety.

Health data standard is a back bone of HIE which facilitate the different systems to communicate,

share and exchange data with full understand in order to achieve the seamless system with semantic interoperability.[2-4]

In 2009, Thai experts met and evaluated eHealth situation in country and provided five recommendations including;

1. Thailand needed authority organization who provide leadership and direction of eHealth
2. Thailand needed eHealth strategy in ICT framework
3. Thailand needed health information legislations to protect people
4. Thailand needed national health data standard to enable interoperable healthcare services
5. Thailand needed mechanism for capacity building of eHealth people.[5]

As mention before, one of the recommendations was the health data standards were needed. Currently, Thailand has a few health data standards such as ICD-9, ICD-10 are used for coding clinical procedures and diagnosis, the 12 files and 18 files are used for storing health data. Unfortunately, the standard for laboratory data is not existed.

Thai Health Information Standard Development Center (THIS) reviewed the international standards for laboratory data and suggested LOINC as a national laboratory standard as LOINC is coverage, nimble, flexible, and easy for adoption.[6]

Logical Observation Identifiers Names and Codes (LOINC) is a terminology standard that was developed by The Regenstrief Institute, Indianapolis, United States of America. It is a universal names and codes system which used for encoding clinical observation and medical laboratory with uniqueness. The adoption of LOINC is growing globally due to the coverage and flexible. Currently, more than 150 countries used LOINC in Laboratory Information System (LIS).[7-8]

Materials and methods

The laboratory test data in this study were collected from three large university hospitals in Thailand, such as
- Ramathibodi hospital
- Siriraj hospital
- Chulalongkorn hospital

In Thailand, the university hospitals are defined as hospital in tertiary level of care. As tertiary hospitals, they provide complex laboratory tests as well as simple laboratory tests performed in hospitals in primary and secondary level of care. Consequently, the university hospital are expected to cover almost entire laboratory tests available.

The Regenstrief LOINC Mapping Assistant (RELMA) version 6.2 which contains LOINC version 2.44 was used as a mapping tool. The study consisted of 6 steps including;

1) Preparing the clinical chemistry test list

The clinical chemistry test lists from three university hospitals were imported to spreadsheet form. Since the test lists from Ramathibodi hospital and Siriraj hospital used the same LIS application named HCLAB, developed by Sysmex (Thailand) Co. LTD, it caused in duplication of data structure for storage of laboratory term. These two hospitals contained five fields in data structure which had similar relationship to six major axes of LOINC. These are the following,

- Test name, related to LOINC component
- Unit, related to LOINC property
- Specimen, related to LOINC system
- Data type, related to LOINC scale
- Method, related to LOINC method

Moreover, the data structure for laboratory test of Chulalongkorn hospital contained only two fields which related to LOINC including test name, and specimen type.

The clinical chemistry test lists of three hospitals were merged into single spreadsheet. The test names which contains Thai alphabet were translated into English by medical experts as the RELMA cannot recognize Thai language.

2) Importing the clinical chemistry test list

After the translation process was done, the combined spreadsheet was imported into RELMA. There are four ways to imported local tests into RELMA including;

- Direct entry of local terms into Local Master Observation File (LMOF) of LOINC database individually

- Create an access table of local terms, which mimic the LMOF structure
- Create a delimited ASCII file of local terms
- Load local terms from Health Level 7 (HL7) directly

The best way for importing is loading local tests from HL7; a massaging standard that used together with LOINC code facilitating exchange and pooling of health data in clinical care.[7] Unfortunately, Thailand does not apply HL7 in its healthcare system. In this study, the clinical chemistry test list was saved in the text format (.txt) with tab delimiter.

3) Verifying the error

RELMA provides 2 verification tools for verifying RELMA unreadable terms, the term verification, and the unit verification. The clinical chemistry test list was performed by both tools.

4) Mapping

The RELMA provides mapping interface which showed the one local test at one time and the mapper can search and select the most appropriated LOINC codes for that local test. The mapping algorithm is shown in **Figure 1** and the mapping results were classified into three types;

- one-to-one mapping: one clinical chemistry test code could be mapped with one LOINC code
- one-to-many mapping: one clinical chemistry test code could be mapped with more than one LOINC code
- unmapped: no appropriate LOINC code for the clinical chemistry test

5) Exporting mapping result

The mapping results were not done in RELMA because it only provides one-to-one mapping result but not for one to many. As a result, after search the appropriated LOINC code for local terms, LOINC codes were exported from RELMA to spreadsheet file and mapped to that local term.

6) Auditing the mapping result

The mapping results were checked the mismatch terms by a medical technologist and a medical doctor in order to reduce the wrong mapping.
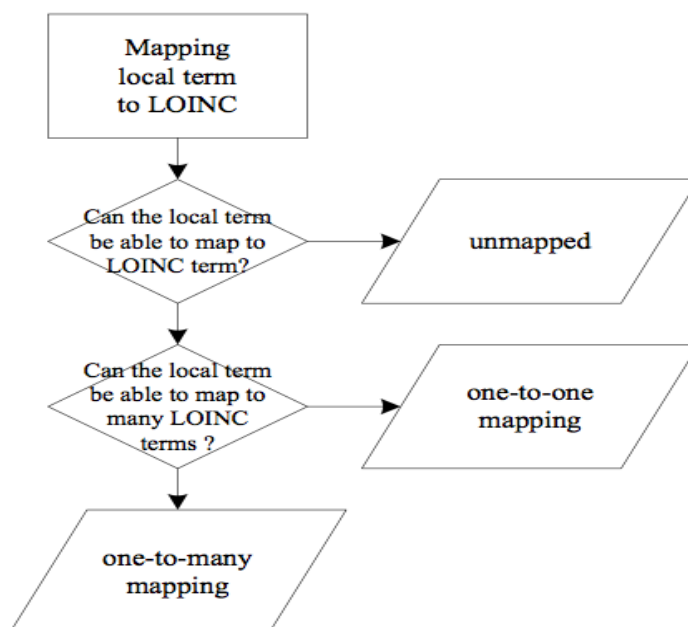

Figure 1: the mapping algorithm[9]

Results

This study collected 744 local clinical chemistry tests which derived from three university hospitals;

1) 432 tests from laboratory information system of Ramathibodi hospital,

2) 222 tests from laboratory information system of Siriraj hospital, and

3) 90 tests from laboratory order list of Chulalongkorn hospital. As shown in **Table 1.**

Table 1 The number clinical chemistry test used classified by data sources

Data sources	Clinical chemistry test	
	N	%
Ramathibodi hospital	432	58.06
Siriraj hospital	222	29.84
Chulalongkorn hospital	90	12.00
Total	744	100.00

The mapping result of clinical chemistry test list to LOINC was almost 95% of which, almost 55% was one-to-one mapping and almost 40% was one-to-many mapping as show in **Table 2.**

Table 2 mapping results of clinical chemistry test classified by hospitals

Data sources	Mapping types			
	one-to-one	one-to-many	unmapped	Total
Ramathibodi hospital	271 (62.73%)	145 (33.57%)	16 (3.70%)	432 (100.00%)
Siriraj hospital	114 (51.35%)	82 (36.94%)	26 (11.71%)	222 (100.00%)
Chulalongkorn hospital	23 (25.56%)	67 (74.44%)	0 (0.00%)	90 (100.00%)
Total	408 (54.84%)	294 (39.52%)	42 (5.64%)	744 (100.00%)

For the local test from Ramathibodi hospital, 96.30% could be assigned by LOINC code of which, 62.73% was one-to-one mapping and 33.57% was one-to-many mapping. The unmapped was occurred 3.70%

For the local test from Siriraj hospital, 88.29% could be mapped to LOINC. 51.35% was one-to-one mapping and 36.94% was one-to-many mapping and 11.71% could not be assigned by LOINC code.

For the local test from Chulalongkorn hospital, all test could be assigned by LOINC code of which, 25.56% was one-to-one and 74.44% was one-to-many mapping.

Discussions and conclusions

In 2006, AgHa Khan et al standardized laboratory tests from five Indian Health Services (IHS) by mapping the local tests to LOINC codes. The results were 81% to 94% of local tests could be mapped to LOINC.[10] And in 2009, Martin Dugas and his colleagues mapped local laboratory of hospital in Germany which was ordered more than ten times annually. The result was more than 93% of local tests could be mapped to LOINC.[11] Moreover in 2012, Thai researchers of Thai Health Information Standard Development center (THIS) evaluated the coverage of LOINC to local

laboratory test of reimbursement list in their country and provided the result as almost 95% of laboratory in the reimbursement list could be mapped to LOINC.[9] As the previous studies, LOINC has potential to be the national standard for laboratory tests in global level.

This study focus on only clinical chemistry discipline because it is a most common and easy for standardizing at the beginning.[7] The result of mapping in three largest university hospitals in country was almost 95% indicated that Thai clinical chemistry tests are compatible with LOINC standard.

Once compare to previous study in Thailand local laboratory tests,[9] the one-to-one mapping results were increased significantly from 23% to 55%. The reason is the university hospital's laboratory test data have high granularity than the laboratory of reimbursement list. There were five data elements of six LOINC axes which can identify laboratory test uniquely. However, the tests from Chulalongkorn hospital are mapped to LOINC with more one-to-many due to data collection site. The study was collected laboratory test data from Ramathibodi hospital and Siriraj hospital via the LIS directly which contained every laboratory detail. On the other hand, the laboratory tests from Chulalongkorn were collected from the laboratory order list which contains only necessary information for helping the physician order laboratory test easily. Again, there were other reasons that lead the mapping to one-to-many. For example, the differential of specimen types which the university hospitals in Thailand collected data less details than LOINC standard as show in **Table 3.**

Table 3 the example of local specimen type compare to LOINC system

Local specimen	LOINC system
Blood	Blood Blood arterial Blood capillary Blood - cord Blood - Mixed Venous Blood - peripheral Blood venous Blood filter paper Plasma Serum Serum/Plasma

Moreover, some of local specimen type determined as "other" which mean any specimen type that lead to map with many LOINC codes as well.

The unmapped 42 tests could be classified in four groups include;

- No appropriated LOINC code

The no appropriated LOINC code has two type including

1) Local lab profile: some local test is a laboratory panel which contains many local tests as used in healthcare services in each hospital. These lab profiles cannot map to LOINC code due to differential of local tests inside themselves. For example, the "OGTT 3 tubes" test which contains three glucose tests includes; glucose 1 hour, glucose 2 hour and glucose point in time do not exist in LOINC.

2) High granularity local test: some local test has more details than LOINC. For instance, the "Challenge test of Estradiol in 20, 90 and 120 minutes" which LOINC only provides code for the challenge test of Estradiol in 30 and 60 minutes.

■ Procedure code

The local test list also has some procedure tests which were performed in clinical chemistry department of three university hospitals such as "DNA Extraction", "PCR 1 Fragment" and "Sequencing with Dye 1 Rxn" tests.

■ Drug specimen

There were the tests that performed in drug specimen such as "steroid testing in drug" and "Bioanalysis in drug". These tests are not found in LOINC.

■ Non laboratory test

Some local tests were used for commenting other laboratory tests which could not be assigned by any LOINC code.

In the future, if LOINC is to be implemented, there might be different opinions for mapping the same laboratory test to LOINC by laboratory experts, who have different background from various healthcare facilities. As a result, the introduction on LOINC standard is recommended to minimize the misinterpretation.

This project studied the coverage of LOINC for clinical chemistry test in Thailand and the coverage was almost 95% of three largest university hospitals. The percentage indicated LOINC is an appropriated standard for chemistry laboratory in Thailand, with potential to use as national standard. However, the study of the LOINC coverage for others laboratory disciplines also need in order to prove the coverage of LOINC for laboratory in healthcare service system in Thailand.

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