Mapping Thai local laboratory codes with LOINC : the preliminary report

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Abstract

Background: Health data standardization is indispensable in Health Information System (HIS) to support the sharing and exchanging of data, especially in semantic interoperability. Recently, Thai healthcare system has adopted an international laboratory coding system, namely, the Logical Observation Identifiers Names and Codes (LOINC), as the national laboratory coding standard. LOINC, a universal coding standard for laboratory information, covers most of the laboratory terms and is broadly used in many countries.

Objective: This study aims to study the extent of the coverage of LOINC terms and codes in local laboratory codes.

Materials and methods: Two local laboratory code lists were studied, 1) The Comptroller General Department of Ministry of Finance's code list and 2) Burirum province hospitals Laboratory Information System's code list. The data were mapped to LOINC codes manually using Regenstrief LOINC Mapping Assistant (RELMA) program.

Results: More than 80% of local laboratory codes were mapped to LOINC codes, of which 23.26% of local laboratory codes were mapped to only one LOINC code and 59.40% were mapped to more than one LOINC code.

Conclusions: The LOINC codes are comprehensive; it covered almost all the Thai healthcare service laboratory terms. The high percentage of mapping result indicates that LOINC is applicable to Thai healthcare services. Since local laboratory codes represented less information about laboratory test than LOINC, the mapping results show high proportion of one-to-many mapping from local codes to LOINC codes. The unmapped codes resulted from the terms using local language and the limited domain knowledge by mappers.

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

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Introduction

Data standardization in health domain is of importance, especially when the computers are broadly utilized in healthcare sector. Standards are foundation of Health Information System (HIS) to support data sharing, exchanging or communicating across the different health related organizations in order to achieve interoperability.[1-3]

In 2009, a group of Thai eHealth experts evaluated eHealth status in the country and provided recommendations. One of the recommendations is that Thailand has inadequate health data standards to enable the national HIS in country. Currently, there are a few health data standards available. For example,

- ICD9-CM (International Classification of Diseases version 9-Clinical Modification) is used for health service intervention,

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- ICD10-TM (International Classification of Diseases version 10-Thai Modification) is used for disease diagnosis statistics, and
- 12 files and 18 files are used for storing health data that request by the government.[2]

To date, there is no standard for laboratory test data in Thailand and each healthcare facility uses its own codes and names in order to serve the internal work flow. As a result, it is impossible to share laboratory data semantically across different health-related organizations. Lack of lab data standards lose out on multiple opportunities including, pooling data for research, human resource management, especially in patient care and safety.[4]

On that account, Thai Health Information Standard Development Center (THIS), an affiliated agency of Heath System Research Institute (HSRI), reviewed four international laboratory data standards in order to find the most suitable laboratory standard for Thai healthcare system and the results were as follows:

- European Clinical Data Exchange (EUCLIDE), currently known as the OpenLabs, is used by many European countries. However, there is no evidence that EUCLIDE can be linked to other standards such as Health Level 7 (HL7), Unified Medical Language System (UMLS), or SNOMED-CT.
- Current Procedural Terminology (CPT), the coding system aimed for payment purposes, does not provide sufficient details to uniquely identify the laboratory test.
- Systematized Nomenclature of Medicine Clinical Terms (SNOMED-CT): Although being the most comprehensive data standard in health sector, the complexity level is the major drawback.
- Logical Observation Identifiers Names and Codes LOINC): It is a unique identifier for medical laboratory and clinical observations. At present, LOINC is the most complete standard in determining the laboratory term globally and is widely used in more than 150 countries. LOINC was developed and is maintained by Regenstrief Institute in Indiana University, United States of America (USA). LOINC has six major axes to identify laboratory test uniquely;
  - Component: a name of analyte measured such as Hemoglobin, Hematocrit and Blood group,
  - Property: a property that indicates kinds of quantities such as volume, substance and mass concentration,
  - Time aspect: time aspect of measurement such as random point in time or specific interval time
  - System: the type of specimen used for the test such as blood, urine and body fluid,
  - Scale: the type of scale such as quantitative, ordinal, nominal and narrative,
  - Method: method of performing the test (only where relevant) such as culture, and automated count.[5-7]

In order to determine the usability of LOINC in practice, the coverage of LOINC in local chemistry tests need to be explored.

LOINC, not only is one of major components which has potential to enable the communication between different systems, but also enables the system to share and exchange laboratory data semantically in order to achieve the better patient care.

The study concluded that LOINC is the most appropriate and has potential to be a national standard for Thailand.[8]

Materials and methods

The study aims to explore the coverage of LOINC for the laboratory tests in Thailand. The material used included 1) the local laboratory test data, and 2) the mapping tool.

1. Local laboratory test data used in this study were drawn from two sources:

- The payment list of Comptroller General Department (CGD), Ministry of Finance, Thailand, which is used for the reimbursement in the Civil Servants Medical Benefits Scheme (CSMBS).
- The local laboratory test list from Hospitals in Burirum province, which is used for healthcare service in all hospitals in the province.

2. Mapping tool: The Regenstrief LOINC Mapping Assistant (RELMA) version 5.6 (LOINC database version 2.38), which was developed by Regenstrief Institute to facilitate users for mapping task. It is applied as a tool for mapping local test to LOINC.

There were four steps in evaluating the coverage of LOINC:

1) Importing local laboratory test list

The importing of local laboratory test list step was required by RELMA for data cleaning process and translation from local language term into English. After performing data cleaning, the local laboratory test list was saved as text file with tab delimiter (text tab delimited).

2) Verifying error term

The RELMA provided verification tool to verify the unreadable term to the understandable term. For example, "phenylketonuria" was changed to "phenylalanine in urine" and "blod", which was a typo, was changed to "blood", etc.

3) Mapping local laboratory test to LOINC

The RELMA provided a friendly mapping interface to facilitate the user's mapping task. The local laboratory tests in the list which was imported in first step were mapped to appropriate LOINC terms by searching the keyword in RELMA.

4) Exporting mapping results

The mapping results were exported in spreadsheet format and descriptive statistics was used to explore LOINC coverage.

The mapping results were classified into three types, namely, one-to-one, one-to-many, and unmapped. The algorithm of mapping is shown in **Figure 1** and the example of mapping results are shown in **Table 1.**

- one-to-one: One local laboratory test can be mapped to one LOINC term.
- one-to-many: One local laboratory test can be mapped to more than one LOINC term.
- unmapped: There is no appropriate LOINC term for the local laboratory test.

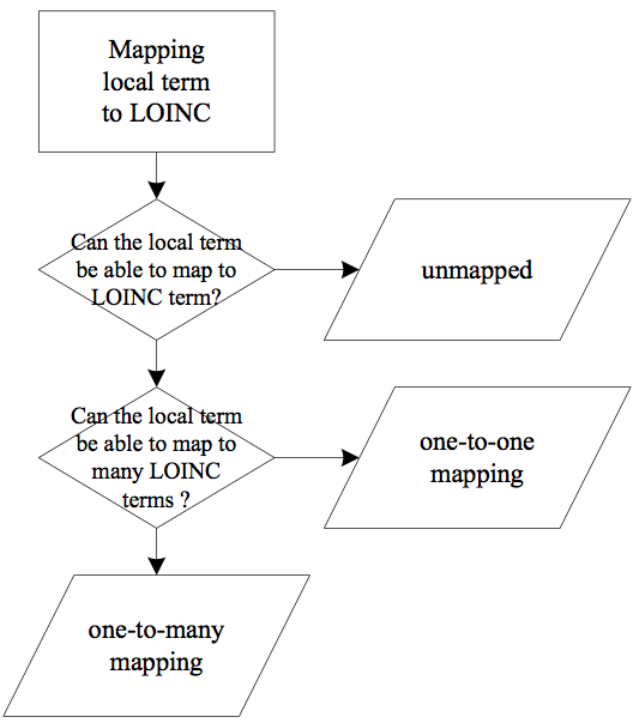

Figure 1: The mapping Algorithm

Table 1 The example of mapping results

Group	Name	LOINC	LOINC name
one-to-one	Paraquat (Urine)	9827-7	Paraquat [Mass/volume] in Urine
		47739-8	Protein [Mass/volume] in Serum or Plasma
		2880-3	Protein [Mass/volume] in Cerebral spinal fluid
		2881-1	Protein [Mass/volume] in Body fluid
one-to-many	ProteinTotal	21482-5	Protein [Mass/volume] in 24 hour Urine
		2886-0	Protein [Mass/volume] in Synovial fluid
		2884-5	Protein [Mass/volume] in Semen
unmapped	Buffy coat		

Results

One thousand four hundred and fifty-three laboratory tests were used in the study of which;

1) 721 tests from the payment list of CGD, which contains two variables related to LOINC axis, namely, code and test name. (RELMA required at least two variables; code and test name)
2) 732 tests from the local laboratory test list from hospitals in Burirum province, which contains three variables related to LOINC, such as code, test name and unit of measurement.

The mapping percentage of Thai laboratory tests to LOINC was more than 80%, of which, 23.26% was one-to-one mapping and 59.40% was one-to-many mapping. The mapping results of laboratory test list from CGD and Burirum province were shown in **Table 2.**

Table 2 The mapping results of local laboratory test lists

Data sources	Mapping types			
	one-to-one	one-to-many	unmapped	Total
CGD	117 (16.23%)	468 (64.91%)	136 (18.86%)	721 (100.00%)
Burirum province	221 (30.19%)	395 (53.96%)	116 (15.85%)	732 (100.00%)
Total	338 (23.26%)	863 (59.40%)	252 (17.34%)	1,453 (100.00%)

One-to-one = one local code mapped to one LOINC code
One-to-many = one local code mapped to many LOINC codes
Unmapped = no LOINC code could be assign for local code

The local tests of the CGD test list were mapped to LOINC with more than 80%, of which, 16.23% was one-to-one mapping and 64.91% was one-to-many mapping. Furthermore, Burirum tests were mapped to LOINC with approximately, 85%, of which, 30.19% was one-to-one mapping and 53.96% was one-to-many mapping.

Table 3 The mapping results of local test list from CGD classified by reimbursement groups

CGD's reimbursement groups	Mapping types			
	one-to-one	one-to-many	unmapped	Total
Laboratory test	84 (16.87%)	359 (72.09%)	55 (11.04%)	498 (100.00%)
Radiology test	26 (14.29%)	100 (54.95%)	56 (30.76%)	182 (100.00%)
Special test	7 (27.07%)	9 (21.95%)	25 (60.98%)	41 (100.00%)
Total	117 (16.23%)	468 (64.91%)	136 (18.86%)	721 (100.00%)

The mapping results of local test list from CGD are classified by reimbursement groups were shown in Table 3. Almost 90% of local test from Laboratory test group were assigned by LOINC. Out of which 16.87% was one-to-one mapping and 72.09% was one-to-many mapping. The radiology and special test groups were mapped to LOINC with 69.34% and 39.02% respectively.

Discussions and conclusions

To date, many countries had studied the coverage of LOINC, for example, Martin Dugas mapped local laboratory document of HIS in University Hospital of Münster, Germany. The result stated that more than 93% of local laboratory document were assigned by LOINC code[9].

Laboratory tests mapping results from reimbursement list of CGD were 81.14% and from Burirum province were 84.15%: Though these high percentages of mapping results represented the coverage of LOINC for Thai laboratory test data, there were almost 20% of local laboratory tests that could not be assigned by LOINC.

The high number of one to many mapping resulted from the high granularity of LOINC, which has six axes (attributes) to identify laboratory term.

However, the laboratory test list from CGD has only two elements (code and test name) to identify the test due to the reimbursement purpose. The laboratory test list from Burirum province has three elements (code, test name and unit of measurement) leading to more percentage of one-to-one mapping. The example of one-to-many mapping was shown in **Table 4.**

The hematocrit test from CGD's list can be assigned to many LOINC that are different in specimen types and methods. Moreover, the total protein test from Burirum's list is mapped to many LOINC as well. Both examples were shown in **Table 4.**

The unmapped results can be explained by the following four reasons:

1. Local language test name

The laboratory test list of CGD contains many laboratory tests with the test name in Thai alphabet. After the data cleaning process (translated Thai to English), the meaning of some local tests were changed. For example, "ทดสอบพยาธิสภาพทางสมอง" was translated into "pathology test in brain" and still cannot find the appropriate LOINC term.

2. Non-generic test name

Some local laboratory tests were referred to as local term which were used conveniently

Table 4 The example of one-to-many mapping type

Local code	Local term	LOINC codes	LOINC terms
30104	Hct	20570-8	Hematocrit [Volume Fraction] of Blood
		4544-3	Hematocrit [Volume Fraction] of Blood by Automated count
		48703-3	Hematocrit [Volume Fraction] of Blood by Estimation
		31100-1	Hematocrit [Volume Fraction] of Blood by Impedance
		4545-0	Hematocrit [Volume Fraction] of Blood by Spun
		32354-3	Hematocrit [Volume Fraction] of Arterial blood
		42908-4	Hematocrit [Volume Fraction] of Capillary blood
126	Protein Total (mg/dl)	47739-8	Protein [Mass/volume] in Serum or Plasma
		2880-3	Protein [Mass/volume] in Cerebral spinal fluid
		2881-1	Protein [Mass/volume] in Body fluid
		21482-5	Protein [Mass/volume] in 24 hour Urine
		2886-0	Protein [Mass/volume] in Synovial fluid
		2884-5	Protein [Mass/volume] in Semen

in reimbursement system and in healthcare services in hospitals, for example, "DCIP test", "Lab score", and "Whole gene sequencing-Peutz-Jeghers syndrome".

3. Non-laboratory test

In this case, the local test lists from two data sources not only contained laboratory tests but also included the non-laboratory test, which are used for reimbursement and assisting work flow of Laboratory Information System (LIS) in the hospital, "service price", "IQ testing", "Blood Donor", and "Physician name", for instance.

4. The mapper knowledge domain

The mapping processing task required specific knowledge in laboratory domains such as hematology, chemistry, microbiology, immunology and other laboratory disciplines. To reduce the errors and achieve the mapping accuracy, the laboratory experts should be recruited to verify the mapping results.

The high percentages of mapping results in this study indicated that LOINC can be adopted and can be used as a national standard for laboratory data in Thailand healthcare system. The adoption can help achieving the interoperability to enable the sharing of laboratory data semantically between health organizations and sharing laboratory data worldwide where the organizations use the same platform.

Besides, this study can be used as a baseline in developing the laboratory test list of the Comptroller General Department (CGD) of Ministry of Finance, which,

in turns, improve the payment method and eventually leads to provide better healthcare in the country.

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