## Linking LOINC and SNOMED CT:

A cooperative approach to enhance each terminology and facilitate co-usage

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II. PLANNED APPROACH

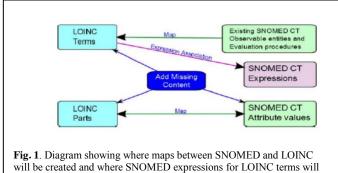
Abstract—A cooperative agreement between the owners of SNOMED CT and LOINC was signed in 2013. Here we describe plans for and benefits of linking the two terminologies, progress thus far, and challenges faced during the initial project phase.

Keywords—LOINC, SNOMED CT, ontology, terminology, Meaningful Use

## I. INTRODUCTION

LOINC and SNOMED CT are medical terminologies that overlap in the area of laboratory medicine. In this domain, LOINC laboratory tests have traditionally represented questions and SNOMED codes have been used as answers to these questions. As both terminologies have a growing international user base and are named in Meaningful Use initiatives in the United States, there is increased interest in enhancing the use of SNOMED and LOINC together to improve the delivery of healthcare.

A cooperative agreement between the Regenstrief Institute (owners of LOINC) and the IHTSDO (owners of SNOMED CT) was ratified in July 2013 [1]. Tenets of this agreement include minimizing further duplication between SNOMED and LOINC, providing linkages between LOINC and SNOMED, enabling the two to work better together, and providing additional value for their use. In January 2014 work commenced on the project with an initial scope of laboratory LOINC.



be developed. Missing content may need to be added to either terminology.

LOINC terms are named by the five main LOINC parts which describe the term: component, property, timing, sample type, and scale. Some LOINC terms include an optional method or additional subparts. SNOMED codes are organized into a polyhierarchical structure and description logic (DL) is utilized to provide linkages between codes following defined models with specified attributes and value types.

The approach to link LOINC and SNOMED follows. The first three items are illustrated in Fig. 1.

1. *Map LOINC parts to SNOMED codes*. This map is not always 1:1. For example, the LOINC part *Leukocytes* could be mapped to the SNOMED code for an individual leukocyte cell or to a code for a population of leukocytes depending on the property type and scale used in a LOINC term.

2. Associate LOINC terms with post-coordinated SNOMED expressions. Each LOINC term will be aligned with a combination of SNOMED attribute and value codes (expressions) intended to represent the meaning of the term. The expressions follow the SNOMED Observables model which partially aligns with Basic Formal Ontology (BFO) and Biotop. An illustrative example of a LOINC term and its equivalent SNOMED expression is shown below.

LOINC Code: 17861-6

LOINC Term Long Common Name: Calcium [Mass/volume] in Serum or Plasma

Equivalent SNOMED Expression:

Is a: Observable entity Specified by: Observation procedure Direct site: Serum or plasma specimen Observes: Quality Inheres in: Plasma Property type: Mass concentration Towards: Calcium Scale: Quantitative

3. Map existing pre-coordinated SNOMED Observable entity and Evaluation procedures to LOINC terms. For example, the SNOMED code for 24 hour urine calcium output measurement (procedure) would be mapped to the LOINC term Calcium [Mass/volume] in 24 hour Urine with a designation that the SNOMED meaning is broader than that of the LOINC term as it does not specify a property type. This mapping will focus on targeted, relevant content areas. 4. Develop lists of SNOMED value sets for LOINC terms. Lists of SNOMED codes that are potential answers to LOINC test questions will be prepared. For example, the LOINC term Mycobacterium sp identified in Body fluid by Organism specific culture could have a value set including the SNOMED identifier and name for all the Mycobacterium species codes (Mycobacterium abscessus, Mycobacterium bovis, etc.)

5. Document and provide guidance for implementing SNOMED and LOINC together. This includes surveys of existing and potential use cases for utilizing SNOMED and LOINC together. Descriptions of how to use them together will be provided in extensive implementation documentation.

## III. ACCOMPLISHMENTS THUS FAR

Projects groups with a distinct focus and membership have formed and meet regularly. Initial efforts have focused on the LOINC parts used to define the top 2000 LOINC lab tests (US and SI versions). An existing map of more than 2200 LOINC parts to SNOMED codes was evaluated and corrected, and around 200 codes were added to SNOMED to complete this partial map. Using this map as a base, an ontology was created in OWL-2-EL including almost 10,000 LOINC terms defined with the SNOMED Observables model. This allowed us to utilize a classifier to identify mismappings and duplication, which led to corrections in our mappings and expressions. The classifier also created hierarchical arrangements of LOINC terms which enabled further evaluation of mappings. 117 LOINC terms mapped to SNOMED codes were released in an alpha prototype OWL file to solicit feedback in May 2014. An additional 9600 LOINC terms will be included in an upcoming Technology Preview release. This release will include postcoordinated SNOMED expressions for each LOINC term. Two drafts of implementation guidance have been released for community feedback.

## IV. CHALLENGES

Establishing meaning and semantic equivalence between terms in LOINC and SNOMED can be challenging. Specific areas of difficulty encountered thus far include:

1. Cases where mapping of LOINC parts to SNOMED codes cannot be 1:1. We will describe two examples. For LOINC terms that describe a property of the specimen (e.g. *Appearance of Urine*), the LOINC component was considered redundant (duplicate of property type) and was not mapped to SNOMED. For LOINC codes containing *Crystals.unidentified* (e.g. *Unidentified crystals [Presence] in Urine sediment by Light microscopy*) the LOINC parts *Crystal.unidentified* (component) and *Light microscopy* (method) were mapped to SNOMED codes: *Crystal – body material (substance)* and *Detecting by light microscopy without classifying (qualifier value)*.

2. Cases where LOINC parts such as *Leukocytes other* do not appear to have a clear, reproducible meaning. Clarification on the intended definition is needed to be able to create an appropriate map.

3. Verifying cases of possible duplication in LOINC or in SNOMED.

4. Cases where SNOMED lacks the type of information needed to complete a map. For example, SNOMED lacked preexisting codes to represent a population of cells so it was necessary to create a new sub-hierarchy for them.

5. Lack of clear differentiation between general categories of classes and specific types, present in both SNOMED and LOINC. Examples include *Amphetamines* (the category of substances) and *Amphetamine* (the specific substance). Reorganizing the existing SNOMED substance hierarchy, revising some terms and creating new codes and terms was necessary to reduce the ambiguity in the area of amphetamines.

## V. SIGNIFICANCE

Improvements in both terminologies are expected and have already been realized on a small scale. Mapping between the two has identified errors, inconsistencies, ambiguities, missing content and duplication within terminologies. Use of description logic in LOINC to identify areas for improvement has previously been reported by Adamusiak and Bodenreider [2]. They found using DL in LOINC can lead to enhanced error detection, navigation, subsumption and maintenance. Quality improvements in SNOMED and LOINC as a result of this project will benefit numerous hierarchies in SNOMED as well as a multitude of users and implementations of SNOMED and LOINC across the globe.

It has been shown that development of a hierarchy of LOINC terms facilitates management of lab reporting for public health reportable diseases [3-4]. Linking LOINC and SNOMED on a larger scale should enhance these efforts as well as create new opportunities for managing and analyzing the secondary use of healthcare data.

## ACKNOWLEDGMENT

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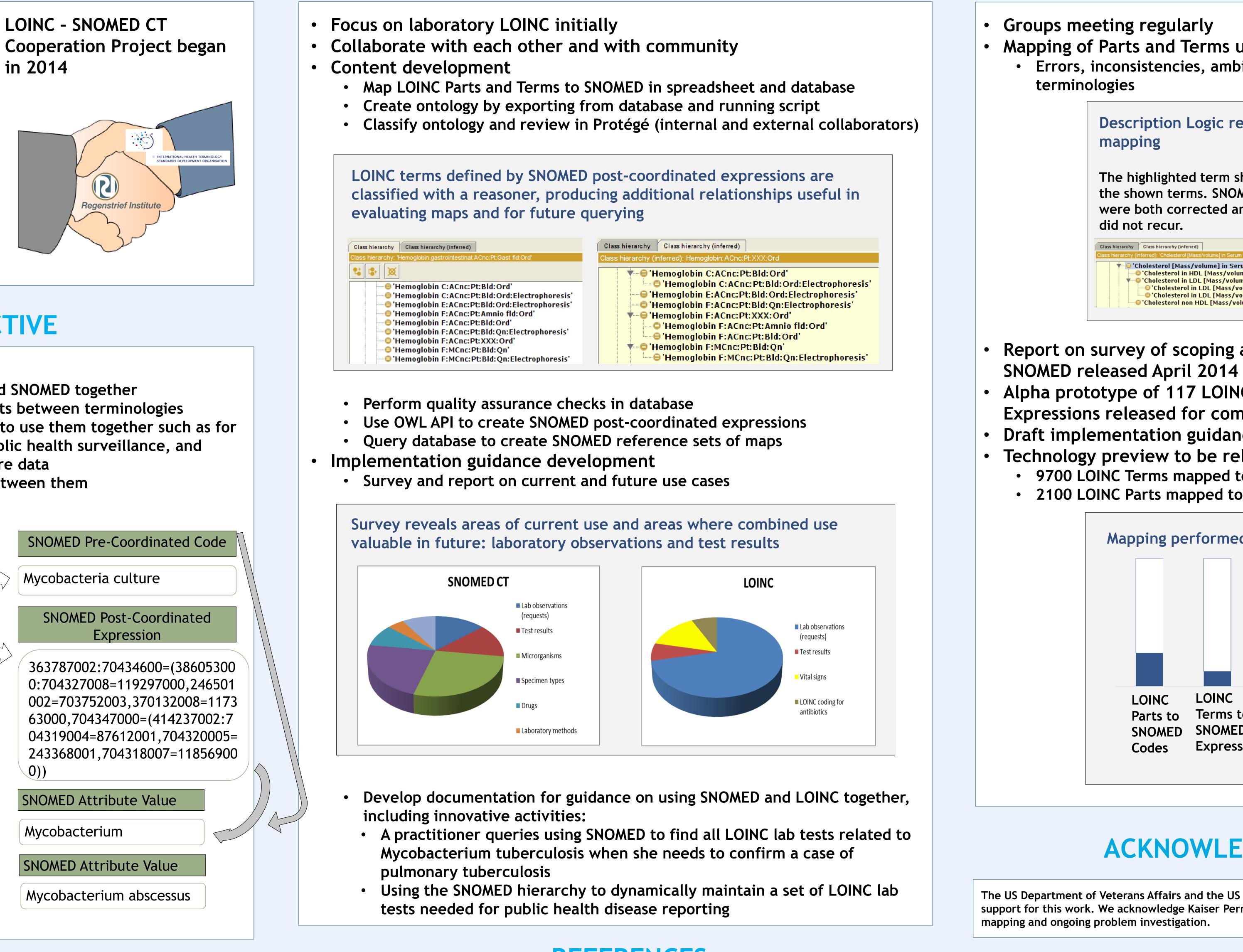
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- [3] K Eilbeck, J Jacobs, S McGarvey, C Vinion and C Staes, "Exploring the use of ontologies and automated reasoning to manage selection of reportable condition lab tests from LOINC," ICBO 2013.
- [4] S Steindel, J Loonsk, A Sim, T Doyle, R Chapman and S Groseclose, "Introduction of a hierarchy to LOINC to facilitate public health reporting," Proc AMIA Symp 2002: 737-41.

# Linking LOINC and SNOMED CT: A Cooperative Approac **Enhance Each Terminology and Facilitate Co-usage** Suzanne Santamaria, Farzaneh Ashrafi, Kent Spackman

## INTRODUCTION

- LOINC and SNOMED CT
  - Terminologies that cover laboratory medicine
  - Different strengths and usage
  - Traditionally used together in microbiology results reporting
- Regenstrief Institute and IHTSDO
  - Signed long-term cooperative agreement in 2013 to work together
- LOINC SNOMED CT in 2014



## **OBJECTIVE**

- Collaborate to: • Make it easier to use LOINC and SNOMED together Provide links in multiple aspects between terminologies Deliver guidance on new ways to use them together such as for clinical decision making, in public health surveillance, and secondary analysis of healthcare data Minimize future duplication between them Improve each terminology LOINC Term is a Mycobacterium sp:ACnc:Pt:Bld:Ord:Organism specific culture equals LOINC Part Mycobacterium sp equals LOINC Answer Mycobacterium abscessus equals

  - SNOMED CT Parser (OWL API): https://github.com/danka74/SnomedCTParser

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## **CURRENT APPROACH**

COOPERATION AGREEMENT dated July 2013 Between The International Health Terminology Standards Development Organisation (IHTSDO) and The Regenstrief Institute, Incorporated (RII): http://www.ihtsdo.org/about-ihtsdo/governance-and-advisory/harmonization/loinc Alpha prototype release file of LOINC SNOMED Cooperation Project: https://csfe.aceworkspace.net/sf/frs/do/viewRelease/projects.snomed\_ct\_international\_releases/frs.3\_other\_releases.loinc\_snomed\_alpha\_prototype

Draft LOINC - SNOMED Implementation Guidance: https://csfe.aceworkspace.net/sf/go/projects.implementation\_and\_innovation\_co/docman.root.community.loinc\_and\_snomed\_ct\_implementati

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## REFERENCES

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## **PRELIMINARY RESULTS**

• Mapping of Parts and Terms underway • Errors, inconsistencies, ambiguities identified and fixed in Description Logic revealed errors in The highlighted term should not subsume the shown terms. SNOMED and the mapping were both corrected and the subsumption Cholesterol [Mass/volume] in Serum or Plasma Cholesterol in HDL [Mass/volume] in Serum or Plasm 'Cholesterol in LDL [Mass/volume] in Serum or Plasma 'Cholesterol in LDL [Mass/volume] in Serum or Plasma by calculation Cholesterol in LDL [Mass/volume] in Serum or Plasma by Direct assay' 'Cholesterol non HDL [Mass/volume] in Serum or Plasma' Report on survey of scoping and current use of LOINC and Alpha prototype of 117 LOINC Terms mapped to SNOMED Expressions released for community feedback May 2014 • Draft implementation guidance released July 2014 Technology preview to be released soon • 9700 LOINC Terms mapped to SNOMED Expressions • 2100 LOINC Parts mapped to SNOMED codes Mapping performed (September 2014) LOINC LOINC LOINC LOINC Terms to Answers to Terms to Parts to SNOMED SNOMED SNOMED **SNOMED** Expressions Codes Codes Codes

## ACKNOWLEDGEMENTS