Foundations of Clinical LOINC

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Brief history of LOINC *(Logical Observation Identifiers Names and Codes)*

- Organized in 1994 by Clement McDonald, MD
- Needed a universal language for observation identifiers
- Began with laboratory observations
- Began adding clinical observations in 1996
- Now includes both laboratory and clinical order and result concepts for health measurements, observations and documents
- Free for use
- Supported by Regenstrief Institute and NLM

LOINC Development

- Led by Daniel Vreeman, Director of LOINC and Health Data Standards at Regenstrief Institute

- Small but exceptional team of system engineers, content developers, program manager and coordinators, and consultants

- Laboratory and Clinical Committees help guide the overall development of LOINC and meet at least two times each year

  - Laboratory LOINC - Clem McDonald, Chair

    - All aspects of tests/measurements done on specimens

  - Clinical LOINC - Stan Huff, Chair

    - All aspects of tests/measurements on a patient

Several subcommittees and workgroups

- Meet throughout the year or for a set period of time

- Nursing subcommittee (Susan Matney, Chair)

- Special topics workgroups
  - Domain-specific topics
  - Naming conventions/modeling in LOINC
  - Specimen-related issues
  - New LOINC requests

- https://loinc.org/workgroups/

The LOINC Community

- Submitters

- Translators

- Premium members

- Adopters

- Forum participants

- Collaborators

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LOINC and other standard terminologies

- LOINC – attributes/observables, universal code system for laboratory and clinical observations

- SNOMED CT – findings/values (mostly) and observables (some)

- RxNORM – values, normalized names for clinical drugs

- IEEE – observables, for medical devices

- ICD – values, International Classification of Diseases

- CPT – values, billing of medical procedures

https://www.hl7.org/fhir/terminologies-systems.html

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Focus of LOINC

- One common identifier for tests or observations that are 'clinically' the same

- Represents the value for 'Observation Identifier' in messaging systems
  - In HL7, OBR-4 – Observation request ID and OBX-3 – Observation result ID

- Represents the name of the observation in other standards, such as DICOM, HL7 CDA, HL7 FHIR

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LOINC in an HL7 message

```
MSH|^~\&||||||19981105131523||ORU^R01|
PID|||100928782^9^M11||Smith^John^J|
OBR||||55417-0^Blood pressure panel^LN|
OBX||CE|8361-8^Body position^LN|
|33586001^Sitting^SCT|
OBX||NM|8479-8^Systolic blood pressure by
palpation^LN||138|mmHg|
OBX||NM|8462-4^Diastolic blood pressure by
palpation^LN||85|mmHg|
```

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LOINC in an XML message (CDA, FHIR)

```xml
<Observation>
... snip ...
 <component>
  <code>
   <coding>
    <system value="http://loinc.org" />
    <code value="8480-6" />
    <display value="Systolic blood pressure" />
   </coding>
  </code>
  <valueQuantity>
   <value value="120" />
   <unit value="mmHg" />
   <system value="http://unitsofmeasure.org" />
   <code value="mm[Hg]" />
  </valueQuantity>
 </component>
```

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Major LOINC categories

- Laboratory LOINC
- Clinical LOINC
- HIPAA attachments
- Survey instruments

Clinical observations/measurements

- Vital signs
- Hemodynamics
- Fluid Intake/Output
- Body measurements
- Ophthalmology measurements
- Oncology findings
- Emergency medicine
- Respiratory therapy
- EKG (ECG)

- Cardiac ultrasound
- Obstetrical ultrasound
- Medications
- Colonoscopy/Endoscopy
- Neurology
- Tumor Registry
- Vaccinations
- Surgical procedures

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Covers observations about a patient that can be made without removing a specimen from them.

Clinical documents

- History & physical notes
- Plan of care notes
- Discharge summaries
- Discharge teaching
- Counseling notes
- Birth/Death certificates
- Consents
- Advance directives
- Operative notes

- Well child visit notes
- Medication management notes
- Legal documents
- Flowsheets
- Action plans
- Prescription list
- Adverse event notes
- Case conference notes
- Radiology reports

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Surveys/assessments (just a few)

- Agency for Healthcare Research and Quality (AHRQ) surveys
- ALS Functional Rating Scale
- Center for Medicare & Medicaid Services (CMS) surveys
- Geriatric Depression Scale (GDS) survey
- howRU outcomes survey
- Morse Fall Scale survey
- National Health Care Survey (NHCS)

- Nursing Management Minimum Data (NMMDS) survey
- Patient Activity Scale (PAS)
- PROMIS surveys
- Unified Parkinson's Disease Rating Scale (UPDRS)
- United States Surgeon General Family Health Tool survey
- Test of Infant Motor Performance (TIMP) survey

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HIPAA attachments category in LOINC

- Contains many (but not all) of the LOINC codes used in HIPAA attachments
- LOINC codes are used in the electronic exchanges of claims attachments between payers and providers to –
  - identify the specific kind of information being communicated (e.g., a discharge summary or diagnostic imaging report)
  - specify certain optional modifier variables for fulfilling the request for information (e.g. a modification to the default time period)
  - identify the attachment (document) type, sections, and individual entries
- Regenstrief works jointly with HL7 Attachments Work Group (AWG)
- More information available at https://loinc.org/attachments/

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The LOINC code

- Unique, permanent numeric code
  - Used to identify test results in electronic reports.
  - No intrinsic structure except last character is a mod 10-check digit (see algorithm in Appendix C of LOINC Users' Guide)
  - LOINC code value can help determine when code was created
  - Never removed from the LOINC database once released
- Fully specified name
  - Six axes separated by a colon
  - Same across all areas/domains in LOINC

<Analyte/Component>:<Property>:<Time aspect>:<System (sample)>:<Scale>:<Method>

Six axes

- Component
  - Ejection fraction, heart beats, cardiac output, head circumference
- Kind of property
  - Angle, area, length, mass, pressure, temperature
- Timing
  - Point in time, study minimum, maximum in 8 hours
- System
  - Tricuspid valve, radius+ulna, ventilator
- Scale
  - Quantitative, ordinal, nominal , narrative
- Method
  - Reported, observed, measured, estimated, ultrasound, spirometry

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Component

The substance or entity that is measured, evaluated, or observed.

- RR interval or duration
- Orifice area (of a heart valve)
- Cardiac output
- Heart beats
- Prosthetic valve type

- Breaths
- Fluid intake
- Walking speed

Component - three main subparts

<[analyte].[subclass].[sub-subclass]> ^ <[time delay] post [amount] [substance] [route]> ^ <adjustment>

- Component/Analyte & subclasses (1st part)
- Challenge (2nd part)
- Adjustment (3rd part)

Component – 1ˢᵗ part

The principal name can be divided further by subclass(es) with a period as the separator. The Component may also contain a divisor (/) when the substance or entity is a ratio or fraction.

<[Component].[subclass].[sub-subclass]>

- Fluid output.wound drain
- Blood flow.systolic.max
- Calorie intake.total
- Births.term
- Glasgow coma score.verbal
- Oxyhemoglobin/Hemoglobin.total

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Component – 2nd part: Challenge

Contains information necessary to interpret "challenge" (or loading or tolerance) tests.

<[time delay] pre/post [amount] [substance] [route]>

- Color^1M post birth (Apgar)
- Body height^post partum
- Body weight^with clothes
- Fluid output.urine^post void
- Breaths^pre inhalation therapy
- Oxyhemoglobin/Hemoglobin.total^during bronchodilation

Component – 3ʳᵈ part: Adjustment

Contains calculations that adjust or correct some measured value.

^^ \<adjustment\>

- Diffusion capacity.carbon monoxide^^adjusted for hemoglobin
- Ejection time^^corrected for heart rate
- Thickness^^adjusted for maternal weight (for nuchal fold in fetus)
- 2-minute Walk Endurance Test - scale score^^adjusted for age

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Property

The characteristic or attribute of the component that is measured, evaluated, or observed.

- Type – selection of subtype
- Prid – presence or identity
- Time – duration of time
- Color – color
- Aper – appearance
- Area - area
- Elpot – voltage

- Len – length
- Mass – mass
- MRat – mass rate (gm/h)
- Pres – pressure
- Temp – temperature
- Fcn – function (of a body part or system)

Timing

The interval of time over which the observation or measurement was made. Timings can include time modifiers (e.g. min, max, mean, first, last).

- Pt - at a point in time (a moment)
- Stdy^min – minimum over the period of a study
- 24H - a twenty four hour shift
- 10H^mean – mean value for a ten hour period
- 8H^max – maximum value in an eight hour period

System

The system (context), setting, or body part about which the observation was made. The second part of the System, the Super System, is separated by a carat (^) and used to indicate the source if it is not the patient.

- Yolk sac^fetus
- Upper GI Tract
- Tricuspid valve
- Ventilator
- Arterial system

- Bladder
- Eye.left
- Bld^Donor
- Outpatient
- Emergency department

Scale

The type of data reported for the substance or entity being observed.

- Qn – quantitative
  - 4, 7.4, 1:8
- Ord – oridinal, the answers can be ranked
  - +/-, 1+, 2+, 3+ ….
  - mild, moderate, severe
  - none, rare, few, moderate, many, loaded

- Nom – nominal, answers with no relative order
  - Stool appearance – liquid, formed
  - Skin color – pink, dusky, cyanotic
  - Chest tube type

- Nar – typically represents a paragraph of text that cannot be enumerated

- Doc – a document that could be in many formats (XML, narrative, etc.)

For surveys/panels – Scale often represented as a dash (-) because the individual elements contained in the set or panel often have different *Scales*

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Method

Procedure used to make the measurement or observation. Method is only included when it makes an important distinction in sensitivity or specificity.

- Measured
- Estimated
- Observed
- Calculated
- US (ultrasound)

- EKG (electrocardiogram)
- Helium rebreathing
- Spirometry
- Manual (done by hand)
- Automated (used an instrument)

Putting it all together – Body weight

LOINC Code	Component	Property	Time	System	Scale	Method
11727-5	Body weight	Mass	Pt	^Fetus	Qn	US+Estimated
29463-7	Body weight	Mass	Pt	^Patient	Qn	
56069-8	Body weight.max	Mass	Pt	^Patient	Qn	Reported
8339-4	Body weight^at birth	Mass	Pt	^Patient	Qn	Measured
56056-5	Body weight^at birth	Mass	Pt	^Patient	Qn	Reported
69461-2	Body weight^at delivery	Mass	Pt	^Mother	Qn	

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Putting it all together – Heart rate

LOINC Code	Component	Property	Time	System	Scale	Method
11948-7	Heart rate	NRat	Pt	^Fetus	Qn	US.measured
55426-1	Heart rate	NRat	XXX^max	Arterial system	Qn	Pedometer
55425-3	Heart rate	NRat	XXX^mean	Arterial system	Qn	Pedometer
32402-0	Heart rate^10M post birth	Fcn	Pt	^Patient	Ord	Apgar
40442-6	Heart rate^post exercise	NRat	Pt	XXX	Qn	
69000-8	Heart rate^sitting	NRat	Pt	Arterial system	Qn	
69001-6	Heart rate^standing	NRat	Pt	Arterial system	Qn	
68999-2	Heart rate^supine	NRat	Pt	Arterial system	Qn	

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Other attributes of a LOINC code

- Units (Example & UCUM)
- Class (Microbiology, Pulmonary, Cardiology)
- Type (Lab, Clinical, Attachments, Survey)
- Short & long names
- Order/Obs status - Order, Observation, or Both

- Status – Trial, Active, Discouraged, Deprecated
- Answer list
- Original survey question text & source
- Formula
- Copyright

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Additional attributes for Survey terms

- Display name in form
- Observation ID in form
- R/O/C status
- Skip logic
- Form coding instructions
- Form context information
- Override answer list & binding (e.g. Normative)

Ancillary data & related codes in LOINC

Ancillary data - labels or "tags" for LOINC terms

- Ask-at-order entry (AOE) observation
- Core playbook term (RSNA)
- Public Health
- Universal lab orders
- Veterinary

Related codes – linked to terms, parts, or answer strings

- IEEE
- RadLex
- NMMDS
- CMS
- SNOMED CT

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NOT part of LOINC code

- The instrument used in testing

- Details about the sample or the site of collection, such as "right antecubital fossa"

- The priority of the testing, e.g., whether stat or routine

- Who verified the result

- The size of the sample collected

- The place of testing (e.g., home, bedside, clinical lab)

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LOINC code development guidelines

- We try to only make names and codes for things that are real concepts (exist in someone's system)

- We do not make all possible permutations that the six axes would allow (no blind cross products)

- We **_do_** make names that allow both atomic (post coordinated) and molecular (pre coordinated) styles

- We **_avoid_** creating codes for concepts that can be represented in the HL7 model
  - No names that include post coordinated fields from other parts of the HL7 message (status, priority, user role)
  - Where we do have codes that overlap with concepts in the HL7 model (e.g., created for users that do not utilize HL7), we specify the corresponding HL7 field in another term attribute
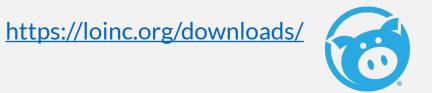
LOINC Version 2.61

- Contains 84868 terms
  - Lab – 53497 (63%)
  - Clinical – 22107 (26%)
  - Attachments – 1288 (1.5%)
  - Survey – 7976 (9.5%)
- LOTS of artifacts
  - LOINC Table Core, Part file, Answer file, Group file, Document Ontology file, LOINC RSNA Playbook file, Panels and Forms file, etc.
- RELMA – a tool for mapping local codes to LOINC and searching the LOINC database

https://loinc.org/downloads/

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So what's with the pig?