LOINC Data Standards and Resources and Their Application for Research

Addressing Gaps, Challenges, and Opportunities Related to Data and Metadata Standards for NIDDK Research Priorities

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Health Data Standards (HDS)

Regenstrief Institute, INC.

Outline

- Background and A bit of history . . .
- Content areas, scope,
- Tour / Demo /Examples

Standards, what's that all about?

A healthcare standard provides the fundamental definitions for and structures of the data that can be communicated in wide variety of healthcare use cases:

- Data exchange (transport, privacy, security)
  - HL7
- Semantics (meaning)
  - LOINC
  - SNOMED CT
  - RxNorm

Standards make health data more portable and understandable

Portable

Syntax Standards

Messages, Documents, APIs

e.g., HL7, C-CDA, FHIR

Physically move data from one place to another in a standardized way

Understandable

Semantic Standards

Clinical Terminologies

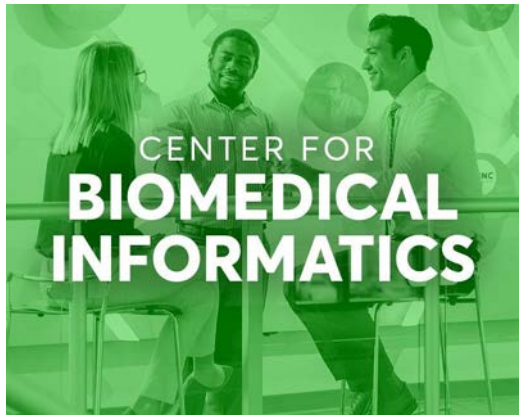
e.g., LOINC, SNOMED CT, RxNorm,

Convey meaning of the data in the message

Background and History

INSTITUTE **STRUCTURE: 3 centers, 2 programs**

Center for Biomedical Informatics



Focused on improving healthcare through data

Center for Heath Services Research

Works to improve the delivery and outcomes of healthcare

IU Center for Aging Research at Regenstrief

Works to improve the delivery and outcomes of healthcare

LOINC & Health Data Standards

Promote adoption of clinical data standards that enable efficient semantic interoperability.

Regenstrief Data Services

Facilitation of research questions from inception to clinical practice

LOINC & Health Data Standards

- Program of Regenstrief since mid 90s
- Focal point for data standards initiatives and policies across Regenstrief
- **Mission:** Promote adoption of clinical data standards that enable efficient semantic interoperability.
- **Vision:** A world where systems get clinicians all the information they need at the right time and place.
- Stewardship for LOINC & UCUM

History of LOINC

(Logical Observation Identifiers Names and Codes)

- Originated in 1994 by Clement McDonald, MD, Indianapolis, IN
- Vision for information technology to help clinicians make better decisions
  - Universal language to describe clinical observations,
    - those observations that occurred during the course of caring for a patient
    - observations that are a result of laboratory testing.

Interconnected systems for data exchange

LOINC adoption around the world

LOINC began in the US and is now used in over 180 countries

LOINC is the official national standard in 30+ countries

International adoption is enabled through LOINC translations (15+ variants in 12 languages)

- Chinese (China) 汉语/漢語;中文
- Dutch (Netherlands) Nederlands
- Estonian (Estonia) eesti keel
- English (United States) *Official Distribution*
- French (Belgium) français
- French (Canada) français
- French (France) français
- German (Austria) Deutsch
- German (Germany) Deutsch
- Greek (Greece) ελληνικά
- Italian (Italy) italiano
- Korean (Korea, Republic of) 한국어
- Polish (Poland) Polski
- Portuguese (Brazil) português
- Russian (Russian Federation) ру́сский язы́к
- Spanish (Argentina) español
- Spanish (Mexico) español
- Spanish (Spain) español
- Turkish (Turkey) Türkçe

LOINC Development

- Maintained by the LOINC team at Regenstrief Institute, Inc. in Indianapolis, IN
- LOINC Committees provide oversight and guidance
  - Laboratory Committee
  - Clinical Committee
    - Nursing subcommittee
    - Document ontology subcommittee
  - LOINC/RadLex Committee
- Vibrant international user community with active participation in LOINC development activities

It takes a village!

Scope

- Standard terminology to identify lab tests, clinical measurements, documents, surveys, and more
- Nearly 105K terms and growing
- 4 major categories of terms
  - Laboratory LOINC
  - Clinical LOINC
  - Attachments HIPAA, HEDIS (Payer/Provider information exchange)
  - Standardized survey instruments

- **One Common Identifier** for results that are clinically the same

Laboratory LOINC

- Routine testing
  - Inpatient hospital lab
  - Outpatient lab
  - Testing done in providers' offices
- Tests performed by patients in their homes
- Specialized laboratory testing ("sendout")
- Newborn screening
- Veterinary
- Public health/Epidemiology

Clinical LOINC

Clinical terms include all types of:

- Measurements, procedures, documents, and other clinical information that are not in the laboratory domain
- Anthropomorphic measurements, vital signs, history and physical exam findings
- Radiology procedures and Interventional procedures such as EKG, Echocardiography, OB ultrasound
- Ophthalmology and other specialties
- Clinical notes

Survey Concepts

- Patient-reported outcomes and provider completed forms
- Functional assessments/symptom indexes
- Government required forms
- Behavioral health/Psychiatry/Substance abuse assessments
- Many of the LOINC term attributes, such as survey question text, observation ID in form, skip logic, and copyright information were created for surveys

Anatomy of LOINC concepts

Structure and design to convey meaning, standardize clinical and laboratory observations, concept model

Concept is a unique unit of thought

LOINC concept = LOINC code + LOINC name: FSN

Name that fully describes the concept is the Fully Specified Name (FSN)

94500-6 SARS coronavirus 2 RNA in Respiratory specimen by PCR

=

94500-6

+

SARS coronavirus 2 RNA in Respiratory specimen by PCR

The LOINC code

- Unique, permanent numeric code
  - Sequential
    - LOINC code value can help determine when code was created
  - No intrinsic structure except last character is a check digit
  - Once officially released, a code is never removed from the LOINC distribution

17856-6 “Hemoglobin A1c/Hemoglobin.total in Blood by HPLC”

- **17856-6 : Hemoglobin A1c/Hemoglobin.total : MFr : Pt : Bld : Qn : HPLC**

  (LOINC) : (Component) : (Property) : (Timing) : (System) : (Scale) : (Method)

- In LOINC, these pieces are called *Parts*

- LOINC *Parts* have codes themselves, starting with “LP”

LOINC pieces (Parts)

- LOINC Parts have *meaning - Conceptual*
- Reusable pieces
- LOINC names (such as LCN) are built by rule-based assembly of LOINC Parts.
- LOINC Parts can be mapped to external ontologies.
- LOINC Parts are hierarchical.

Each LOINC concept is defined by *6 Parts*

Part	Description
Component	The analyte being measured
Property	The dimension of the analyte that is being measured
Time aspect	Whether the analyte is measured at a moment in time or over a specific period of time
System	The type of sample
Scale	A general classification of the result type, whether quantitative, qualitative, narrative, etc.
Method	How the analyte was measured **The Method is the only major axis that does not have to be populated for every LOINC term*

6 parts = clinically relevant information

Putting the *Parts* together

Component	*Property*	*Time aspect*	*SystemB*	*Scale*	*Method*
Sodium	SCnc	Pt	Urine	Qn	
2955-3 *Sodium [Moles/volume] in Urine*					
Sodium	SCnc	Pt	CSF	Qn	
2948-8 *Sodium [Moles/volume] in Cerebral spinal fluid*					
Body weight	Mass	Pt	^Patient	Qn	
29463-7 *Body weight*					
Body weight	Mass	Pt	^Fetus	Qn	US+Estimated from AC
11728-3 *Fetal Body weight estimated from Abdominal circumference on US*					

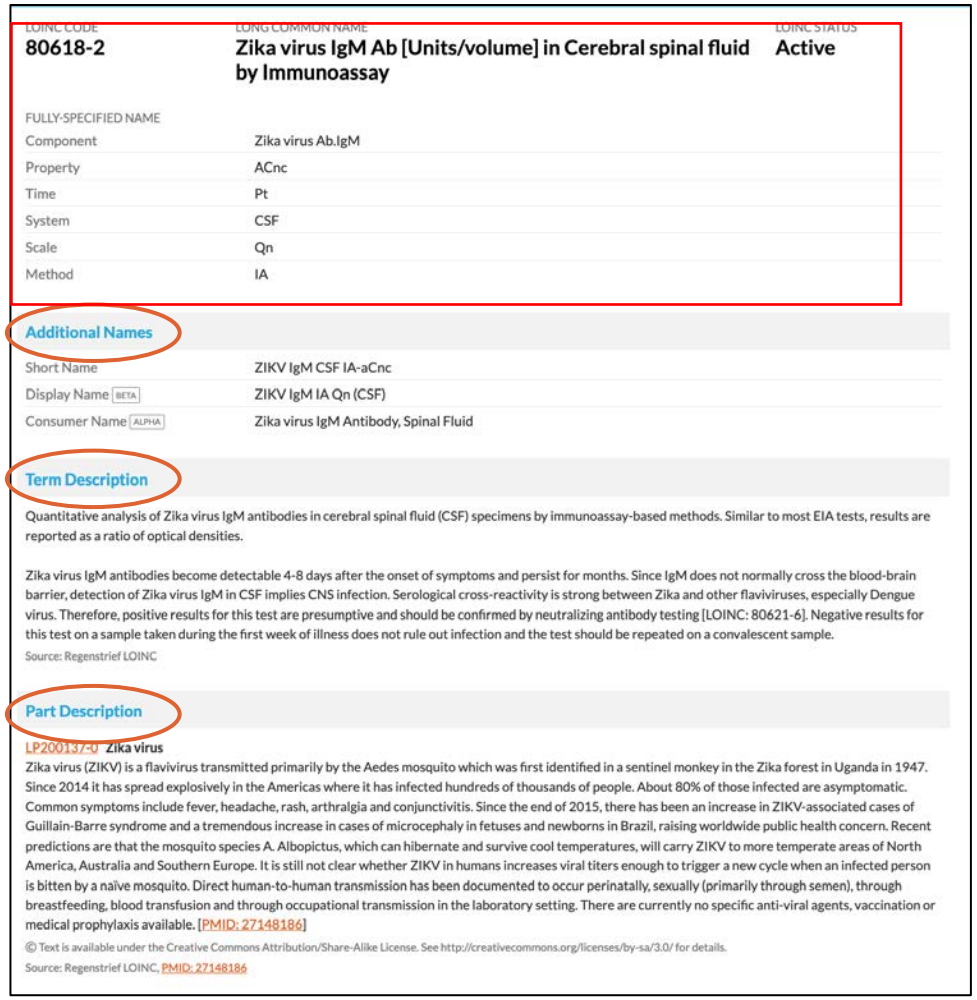
Other concept attributes

- The *6 Parts* define a given concept
- However, many other attributes are associated with each term for different purposes:
  - To help users understand the meaning of the term
  - To organize terms and make them easier to find
  - To provide metadata, such as the version in which the concept was first published or most recently updated
  - To provide information surrounding the use of a term, such as copyright information

Attribute examples (there are others)

Attribute	Description	Examples
Units	Example units of measure associated with the result, including submitted units and UCUM units	mg/dL, kg, cm/s, mm^2
Formula	The calculation used to determine the result	Ejection fraction=[(LV end-diastolic volume-LV end-systolic volume)/LV end-diastolic volume]*100
Type	General classification of the type of observation	1 (Laboratory), 2 (Clinical), 3 (HIPAA Attachments), 4 (Survey)
TypeName	Name of the classification	Laboratory, Clinical, Attachment, Survey
Class	More specific classification within a type	Microbiology, Chemistry, Cardiology, Radiology, PROMIS surveys
Status	The state of the term	Active, Discouraged, Deprecated, Trial
Order/Obs	Whether a term is an order, observation, or both	Order, Observation, Both

All of a concept's features, and attributes are on its details page



LOINC CODE
80618-2

LONG COMMON NAME
Zika virus IgM Ab [Units/volume] in Cerebral spinal fluid by Immunoassay

LOINC STATUS
Active

FULLY-SPECIFIED NAME

Component	Zika virus Ab.IgM
Property	ACnc
Time	Pt
System	CSF
Scale	Qn
Method	IA

Additional Names

Short Name	ZIKV IgM CSF IA-aCnc
Display Name BETA	ZIKV IgM IA Qn (CSF)
Consumer Name ALPHA	Zika virus IgM Antibody, Spinal Fluid

Term Description

Quantitative analysis of Zika virus IgM antibodies in cerebral spinal fluid (CSF) specimens by immunoassay-based methods. Similar to most EIA tests, results are reported as a ratio of optical densities.

Zika virus IgM antibodies become detectable 4-8 days after the onset of symptoms and persist for months. Since IgM does not normally cross the blood-brain barrier, detection of Zika virus IgM in CSF implies CNS infection. Serological cross-reactivity is strong between Zika and other flaviviruses, especially Dengue virus. Therefore, positive results for this test are presumptive and should be confirmed by neutralizing antibody testing [LOINC: 80621-6]. Negative results for this test on a sample taken during the first week of illness does not rule out infection and the test should be repeated on a convalescent sample.

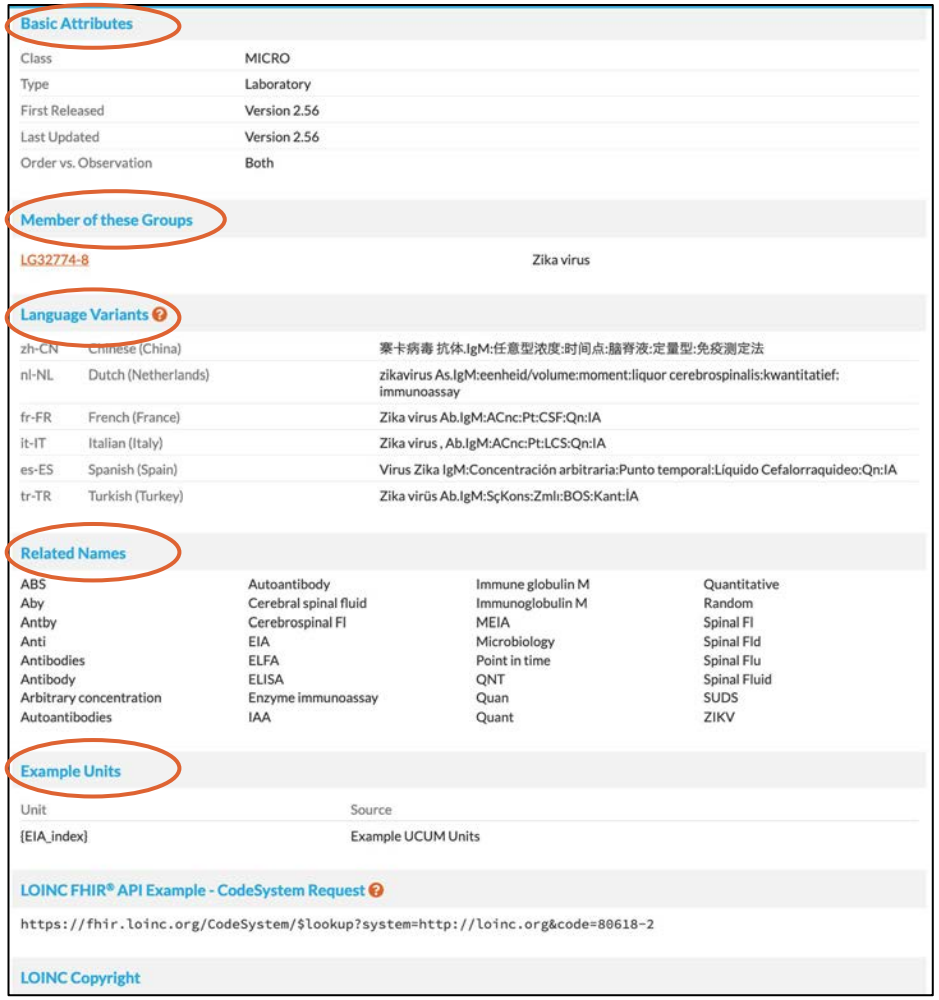
Source: Regenstrief LOINC

Part Description

LP200137-0 **Zika virus**

Zika virus (ZIKV) is a flavivirus transmitted primarily by the Aedes mosquito which was first identified in a sentinel monkey in the Zika forest in Uganda in 1947. Since 2014 it has spread explosively in the Americas where it has infected hundreds of thousands of people. About 80% of those infected are asymptomatic. Common symptoms include fever, headache, rash, arthralgia and conjunctivitis. Since the end of 2015, there has been an increase in ZIKV-associated cases of Guillain-Barre syndrome and a tremendous increase in cases of microcephaly in fetuses and newborns in Brazil, raising worldwide public health concern. Recent predictions are that the mosquito species A. Albopictus, which can hibernate and survive cool temperatures, will carry ZIKV to more temperate areas of North America, Australia and Southern Europe. It is still not clear whether ZIKV in humans increases viral titers enough to trigger a new cycle when an infected person is bitten by a naïve mosquito. Direct human-to-human transmission has been documented to occur perinatally, sexually (primarily through semen), through breastfeeding, blood transfusion and through occupational transmission in the laboratory setting. There are currently no specific anti-viral agents, vaccination or medical prophylaxis available. [PMID: 27148186]

Source: Regenstrief LOINC, PMID: 27148186



Basic Attributes

Class	MICRO
Type	Laboratory
First Released	Version 2.56
Last Updated	Version 2.56
Order vs. Observation	Both

Member of these Groups

LG32774-8	Zika virus

Language Variants

zh-CN	Chinese (China)	寨卡病毒 抗体.IgM:任意型浓度:时间点:脑脊液:定量型:免疫测定法
nl-NL	Dutch (Netherlands)	zikavirus As.IgM:eenheid/volume:moment:liquor cerebrospinalis:kwantitatief: immunoassay
fr-FR	French (France)	Zika virus Ab.IgM:ACnc:Pt:CSF:Qn:IA
it-IT	Italian (Italy)	Zika virus , Ab.IgM:ACnc:Pt:LCS:Qn:IA
es-ES	Spanish (Spain)	Virus Zika IgM:Concentración arbitraria:Punto temporal:Líquido Cefalorraquídeo:Qn:IA
tr-TR	Turkish (Turkey)	Zika virüs Ab.IgM:SçKons:Zmı:BOS:Kant:İA

Related Names

ABS	Autoantibody	Immune globulin M	Quantitative
Aby	Cerebral spinal fluid	Immunoglobulin M	Random
Antby	Cerebrospinal Fl	MEIA	Spinal Fl
Anti	EIA	Microbiology	Spinal Fld
Antibodies	ELFA	Point in time	Spinal Flu
Antibody	ELISA	QNT	Spinal Fluid
Arbitrary concentration	Enzyme immunoassay	Quan	SUDS
Autoantibodies	IAA	Quant	ZIKV

Example Units

Unit	Source
{EIA_index}	Example UCUM Units

LOINC FHIR® API Example - CodeSystem Request

```
https://fhir.loinc.org/CodeSystem/$lookup?system=http://loinc.org&code=80618-2
```

LOINC Copyright

Relationships to other terminologies

- LOINC has links to external terminologies at multiple levels (terms, parts,), e.g.,
  - RXNorm
  - SNOMED CT
  - Others…
- LOINC is the question, other terminologies provide the answer
  - LOINC: What is the patients body weight?
  - SNOMED X pounds
  - LOINC: What is the patients blood type:
  - SNOMED: O+

RECOMMENDED CODE SETS- Quality Measure Reporting

- Laboratory tests
  - LOINC for test name and its results
  - UCUM for units of Measure
- Medication RxNorm for medications
- Physical Exam
  - LOINC for assessment instrument
  - SNOMED-CT for appropriate responses
- Intervention (forms one end of a spectrum with Procedures)
  - LOINC for interactions that produce an assessment or measurable results
  - SNOMED-CT for appropriate results and interventions that do not produce measurable results (e.g., counseling)

Tour LOINC

Panel Browser

- LOINC Panels
  - **Laboratory Order Panels**

Allergy Panels 50	Antibiotic Susceptibility Panels 38	Blood Bank Panels 19	Cellmarker Panels 34	Challenge Bank Panels 44	Chemistry Panels 367	Coagulation Panels 51
Fertility Panels 7	Hematology and Cell Count Panels 70	HEDIS panels 184	HLA Panels 21	HNA panels 3	HPA Panels 1	Microbiology Panels 405
Molecular Pathology Panels 66	Obstetrical Panels 1	Pathology panels 10	Serology Panels 74	Specimen panels 2	Urinalysis Panels 32	

Panel Browser

- LOINC Panels
  - Laboratory Order Panels
    - **Microbiology Panels**

LOINC	Long Common Name
96910-5	Acanthamoeba sp and Naegleria fowleri and Balamuthia mandrillaris DNA panel – Specimen
24363-4	Acute hepatitis 2000 panel – Serum
92852-3	Adenovirus and Bocavirus DNA panel – Lower respiratory specimen by NAA with probe detection
92853-1	Adenovirus and Bocavirus DNA panel – Upper respiratory specimen by NAA with probe detection
80374-2	Adenovirus and Norovirus and Rotavirus Ag panel – Stool by Rapid immunoassay
55160-6	Adenovirus IgG and IgM panel – Serum
85810-0	Adenovirus serotype DNA panel – Specimen by NAA with probe detection
91899-5	Anaplasma phagocytophilum and Ehrlichia chaffeensis DNA panel – Blood
93370-5	Anaplasma phagocytophilum and Ehrlichia chaffeensis IgG and IgM panel – Serum
77165-9	Anaplasma phagocytophilum and Ehrlichia chaffeensis IgG panel [Titer] – Serum
87548-4	Anaplasma phagocytophilum and Ehrlichia sp DNA panel – Blood Qualitative by NAA with non-probe detection
55150-7	Anaplasma phagocytophilum IgG and IgM panel – Serum Qualitative
49094-6	Arbovirus IgG and IgM panel – Cerebral spinal fluid by Immunofluorescence
49093-8	Arbovirus IgG and IgM panel – Serum by Immunofluorescence
53804-1	Arbovirus IgG panel – Serum by Immunofluorescence

55160-6	Adenovirus IgG and IgM panel – Serum
35810-0	Adenovirus serotype DNA panel – Specimen by NAA with probe detection
91899-5	Anaplasma phagocytophilum and Ehrlichia chaffeensis DNA panel – Blood
93370-5	Anaplasma phagocytophilum and Ehrlichia chaffeensis IgG and IgM panel – Serum
77165-9	Anaplasma phagocytophilum and Ehrlichia chaffeensis IgG panel [Titer] – Serum
87548-4	Anaplasma phagocytophilum and Ehrlichia sp DNA panel – Blood Qualitative by NAA with non-probe detection
55150-7	Anaplasma phagocytophilum IgG and IgM panel – Serum Qualitative
49094-6	Arbovirus IgG and IgM panel – Cerebral spinal fluid by Immunofluorescence
49093-8	Arbovirus IgG and IgM panel – Serum by Immunofluorescence
53804-1	Arbovirus IgG panel – Serum by Immunofluorescence
74032-4	Arbovirus IgM panel – Serum
90439-1	Atypical pneumonia pathogens panel – Respiratory specimen by NAA with probe detection
67866-4	Babesia identification panel – Specimen
88461-9	Babesia microti and B. divergens+MO-1 and B. duncani 18S rRNA gene panel – Blood by NAA with non-probe detection
34940-7	Babesia microti IgG and IgM panel – Serum
88728-1	Babesia microti IgG and IgM panel – Serum by Immunofluorescence
43131-2	Bacterial Ag panel – Cerebral spinal fluid
43434-0	Bacterial Ag panel – Serum
43443-1	Bacterial Ag panel – Urine
35421-6	Bacterial identification and susceptibility panel – Isolate
87927-0	Bacterial susceptibility panel – Isolate by Minimum lethal concentration (MLC)
54145-8	Bacterial vaginosis and vaginitis DNA panel – Vaginal fluid by Probe with signal amplification
46999-9	Bacterial vaginosis and vaginitis rRNA panel – Vaginal fluid by Probe

LOINC

LOINC CODE
43131-2

LONG COMMON NAME
Bacterial Ag panel - Cerebral spinal fluid

Panel Hierarchy

Details for each LOINC in Panel | LHC-Forms

LOINC	Name	R/O/C	Card
43131-2	Bacterial Ag panel - Cerebral spinal fluid		
24010-1	Haemophilus influenzae B Ag [Presence] in Cerebral spinal fluid		
24017-6	Neisseria meningitidis serogroup B Ag [Presence] in Cerebral spinal fluid		
31824-6	Escherichia coli K1 Ag [Presence] in Cerebral spinal fluid		
20489-1	Streptococcus pneumoniae Ag [Presence] in Cerebral spinal fluid		

Fully-Specified Name

Component	Bacterial Ag panel
Property	-

Fully-Specified Name

Component	Haemophilus influenzae B Ag
Property	PrThr
Time	Pt
System	CSF
Scale	Ord
Method	

Additional Names

Short Name	Haem influ B Ag CSF QI
Display Name	H. influenzae B Ag QI (CSF)
Consumer Name ALPHA	Haemophilus influenzae B antigen, Spinal fluid

Basic Attributes

Class	MICRO
Type	Laboratory
First Released	Version 1.0o
Last Updated	Version 2.56
Change Reason	The PrThr property is used for LOINC terms whose results are reported using an ordered categorical scale,

Panel Browser

- LOINC Panels
  - **Laboratory Order Panels**

Allergy Panels 50	Antibiotic Susceptibility Panels 38	Blood Bank Panels 19	Cellmarker Panels 34	Challenge Bank Panels 44	Chemistry Panels 367	Coagulation Panels 51
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Panel Browser

- LOINC Panels
  - Laboratory Order Panels
    - **Allergy Panels**

LOINC	Long Common Name
87553-4	Aspergillus fumigatus and Saccharopolyspora rectivirgula and Thermoactinomyces vulgaris IgG panel – Serum
51662-5	Core respiratory allergens panel – Serum
49222-3	Food allergen panel – Serum
35577-6	Hypersensitivity pneumonitis panel – Serum
96185-4	Indoor respiratory allergen IgE panel – Serum
94593-1	Multiplex allergen panel – Serum or Plasma
63486-5	Nut allergen panel – Serum
35575-0	Pigeon antibody panel – Serum
48841-1	Respiratory allergen panel, US – Alaska a – Serum
48932-8	Respiratory allergen panel, US – Alaska b – Serum
48835-3	Respiratory allergen panel, US – Arid southwest – Serum
48931-0	Respiratory allergen panel, US – AZ, Southeastern CA, Western NM – Serum

LOINC CODE
49222-3

LONG COMMON NAME
Food allergen panel - Serum

Term Description

This panel is used to order allergy testing for common food allergens. The children contained in the panel are representative term
food allergen tested in a particular geographic location or by a specific lab. Each reporting laboratory should use the set of LOINC
reporting the results for the individual tests performed, even if all of those LOINC codes are not included in this panel.

Source: Regenstrief LOINC

Panel Hierarchy

Details for each LOINC in Panel | LHC-Forms

LOINC	Name	R/O/C	Cardinality
49222-3	Food allergen panel - Serum		
7258-7	Cow milk IgE Ab [Units/volume] in Serum		
6106-9	Egg white IgE Ab [Units/volume] in Serum		
6276-0	Wheat IgE Ab [Units/volume] in Serum		

LOINC CODE
7258-7

LONG COMMON NAME
Cow milk IgE Ab [Units/volume] in Serum

LOINC STATUS
Active

Part Description

LP17181-6 **Cow milk**

Cow's milk is a major cause of adverse reactions in infants and hidden exposure is common. Casein (cheese) is a heat-stable allergen while whey proteins are altered by boiling.

Source: ImmunoCap, ImmunoCap

Fully-Specified Name

Component	Cow milk Ab.IgE
Property	ACnc
Time	Pt
System	Ser
Scale	Qn
Method	

Additional Names

Basic Attributes

Class	ALLERGY
Type	Laboratory
First Released	Version 1.0h(2)
Last Updated	Version 2.54
Order vs. Observation	Both
Common US Lab Results Rank	662
Common SI Lab Results Rank	662

Member of these Panels

LOINC	Long Common Name
49222-3	Food allergen panel - Serum

Language Variants

zh-CN	Chinese (China)	牛奶 抗体.IgE:任意型浓度:时间点:血清:定量型:
nl-NL	Dutch (Netherlands)	koemelk As.IgE:eenheid/volume:moment:serum:kwantitatief:
et-EE	Estonian (Estonia)	Lehmapiim antikehad.IgE:Acnc:Pt:S:Qn:
fr-BE	French (Belgium)	Lait de vache Anticorps.IgE:Concentration arbitraire:Temps ponctuel:Sérum:Quantitatif:
fr-CA	French (Canada)	Lait de vache , IgE:Concentration arbitraire:Temps ponctuel:Sérum:Quantitatif:
fr-FR	French (France)	Lait de vache Ac IgE:Arbitraire/Volume:Ponctuel:Sérum:Numérique:

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