Health Information Technology

Newborn Screening Health Information Exchange: Updated Guidance for Coding and HL7 Electronic Messaging

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Benefits of Standardizing NBS Data

- Rapid reporting and exchange
  - Send results to multiple recipients at the same time
- Share data
  - Follow-up
  - Border states and Disaster preparedness
- Gather and re-use data
  - Enable cross-referencing with other data sources (e.g. birth certificates, hearing screen results, immunization registries)
- Aggregate data for research and QA

Background

- Developing the HRSA/NLM guidance for sending electronic NBS result messages has been a collaborative effort with input from federal and state agencies and organizations
- Guidance is based on nationally-accepted standards
  - LOINC® - for test results and card variables
  - SNOMED CT - for NBS conditions
  - UCUM© - units of measure for quantitative results
  - HL7 – for electronic messaging using above codes
- Approved by the SACHDNC* Laboratory Standards and Procedures subcommittee
- Initially released Sept 2009

* Secretary's Advisory Committee on Heritable Disorders in Newborns and Children

What has to be standardized?

- **Messaging format**
  - (the “egg carton” container)
  - Standard messaging format to convey the content electronically
  - HL7
- **Content**
  - (the “eggs”)
  - Standard codes for test names, analytes, conditions screened and other categorical answers
  - LOINC and SNOMED CT

Refining the HRSA/NLM Guidance

Iterative Process

- Close gaps and achieve consensus
  - State Implementation
  - PHII HL7 implementation guides for NBS orders and results
  - SACHDNC Laboratory Standards and Procedures Subcommittee
  - APHL Newborn Screening and Genetics in Public Health Committee


12:03:0
13:03:0

New LOINC codes created for:

- Birth hospital facility, discharge provider/practice
  - ID, Name, address, phone number
- Test methods/analytes
  - Hemoglobin screening results
  - Underivatized MS/MS
- Card data – factors that affect NBS interpretation
- NBS report summary and NBS interpretation answers
- New conditions

Factors that Affect Newborn Screening Interpretation

Original clinical events → 3 new questions

57713-0	Clinical events that affect newborn screening interpretation

NORMATIVE ANSWER LIST:

SEQ#	Answer	Answer ID
1	None	LA137-2
2	Any blood product transfusion before NBS specimen	LA12417-4
3	TPN	LA12418-2
4	Soy or hydrolyzed formula	LA14041-0
5	Infant in ICU at time of specimen collection	LA12419-0
6	Systemic antibiotics before NBS specimen	LA12420-8

- Feedback from multiple NBS programs and SACHDNC Lab subcommittee that original Clinical events list was incomplete
- Developed new codes for:
  - Infant NICU factors that affect NBS
  - Feeding types
  - Maternal factors that affect NBS

57713-0 Infant NICU Factors that affect NBS – expanded list and new name

- None
- Infant in ICU at time of specimen collection
- Any blood product transfusion (including ECMO)***
  - *Plus separate LOINC code for Date of last blood product transfusion*
- Dopamine
- Topical iodine
- Parenteral steroid treatment
- Systemic antibiotics before newborn screening specimen***
- Meconium ileus or other bowel obstruction
- Other → *Plus additional LOINC code to give details in free text*

*** Answer was on the original Clinical events list

67704-7 Feeding Types – new code

- Breast milk
- Lactose formula
- Lactose free formula (including soy or hydrolyzed)***
- NPO
- TPN***
- Carnitine
- MCT (medium-chain triglyceride) oil
- IV dextrose
- Other → *plus additional code to give details in free text*
- Unknown

*** Answer was on the original Clinical events list

67706-2 Maternal Factors that affect NBS – new code

- None
- HELLP syndrome
- Fatty liver of pregnancy
- Packed red blood cell (PRBC) transfusion
- Steroid treatment
- Thyroid treatment (including propylthiouracil (PTU), methimazole (Tapazole), or past treatment with radioactive iodine (I-131))
- TPN
- Other → *plus additional code to give details in free text*

NBS Interpretation and Report Summary

Overall NBS interpretation (LOINC code 57130-7)

- All screening is normal
- Screening is borderline for at least one condition
- Not normal requiring further filter paper testing for at least one condition
- Not normal requiring immediate non filter paper follow up for at least one condition
- Screening not done due to parental refusal → **NEW**
- One or more tests pending → **NEW**
- Specimen unsatisfactory for at least one condition → **NEW**

Reason for lab test in Dried blood spot (LOINC code 57721-3)

- Streamlined list:
  1. Initial screen
  2. Subsequent screen - required by law
  3. Subsequent screen - required by protocol
  4. Subsequent screen – for clarification of initial results (not by law or protocol)
  5. Subsequent screen – reason unknown
  6. No sample collected due to parental refusal → **NEW**

- Defined each of the answers.

New Conditions: SCID and Lysosomal Storage Disorders

62333-0 Severe Combined Immunodeficiency (SCID) newborn screening panel

LOINC Code	LOINC (Analyte) Name	Data Type	Units
62321-5	Severe combined immunodeficiency newborn screen interpretation	CE	
62322-3	Severe combined immunodeficiency newborn screen comment-discussion	TX	
62320-7	T-cell receptor excision circle [#/volume] in Dried blood spot by Probe & target amplification method	NM/ ST	{copies}

Condition Name (and Abbreviation)	SNOMED CT code
Severe Combined Immunodeficiency (SCID)	31323000

Lysosomal Storage Disorders (LSDs)

- Several states have started pilot studies or implemented screening for these lysosomal storage disorders:

  Fabry disease, Pompe disease, Gaucher disease, Krabbe disease, and Niemann-Pick disease A/B

- Genetic mutations cause specific enzyme deficiencies.
  - These enzymes are normally responsible for catalyzing breakdown of waste material in cells, so in people with LSDs, waste materials accumulate in the lysosomes.
  - Research and emerging therapies.
  - **Early detection is vital.**

Standardizing LSD NBS Reporting

- Challenges to standardizing:
  - Each lysosomal storage disorder can have multiple names based on researchers' names, related genes, and affected enzymes.
  - No consensus on naming conditions and tests, reporting screening results, or screening method.
  - Special characters (Greek letters in enzyme names and units of measure) may not be computer-readable.

Standardizing LSD NBS Reporting

- Creating standards
  - ACMG LSD expert workgroup* published guidelines for diagnostic confirmation and management of **presymptomatic** individuals with lysosomal storage disorders.
    - Wang RY, et al. Genet Med. 2011 May;13(5):457-84. PMID 21502868
  - HRSA and NLM developed a panel of standard NBS names and LOINC and SNOMED CT codes to use in HL7 messages for standardizing electronic reporting of LSD screening results.

*With funding from NIH NICHD. Part of the Newborn Screening Translational Research Network.

Pompe disease – condition name variants

- **Pompe disease** – after Dutch pathologist Dr Joannes Cassianus Pompe, who first recognized Pompe disease
- **Acid alpha glucosidase deficiency** – affected enzyme
- **Acid maltase deficiency** – affected enzyme (synonym)
- **Glycogen Storage Disease Type II** – glycogen is the material that accumulates in the lysosome as a result of the enzyme deficiency
- **GAA** – gene mutation that causes Pompe disease

Wang RY, et al. Genet Med. 2011 May;13(5):457-84. PMID 21502868.

NLM Genetics Home Reference. "How are genetic conditions and genes named?" Published October 24, 2011. http://ghr.nlm.nih.gov/handbook/mutationsanddisorders/naming

Name Variants for the Enzyme Affected

by GBA gene mutation in Gaucher Disease

Source	Enzyme Name
American College of Medical Genetics (ACMG) LSD Workgroup	acid β-glucosidase
Scriver's Online Metabolic and Molecular Bases for Inherited Disease (OMMBID)	Acid β-glucosidase
LOINC (14 terms existing Oct 30, 2010)	Beta glucosidase
OMIM 606463	Glucosidase, beta, acid (GBA) (alternative titles" include: Acid beta-glucosidase, glucocerebrosidase, and glucosylceramidase)
E.C. 3.2.1.45	Glucosylceramidase - accepted name (12 "other names" include acid β-glucosidase and glucocerebrosidase)
UniProt P04062	Glucosylceramidase - recommended name (5 alternative names include Acid beta-glucosidase and Beta-glucocerebrosidase)

LOINC Name Selected for Newborn Screening Assay to Detect Activity of the Enzyme Affected in Gaucher Disease:

Acid beta glucosidase

- Computer-readable version of "Acid β-glucosidase" -- the name from ACMG and Scriver's Online Metabolic and Molecular Bases for Inherited Disease (OMMBID).
  - "beta" instead of Greek letter symbol "β" to ensure that electronic message recipients properly display the name.
- Scriver's OMMBID rationale:
  - "The enzymatic defect in Gaucher disease was shown to be due to impaired glucosylceramide hydrolysis ...Because glucosylceramide (glucocerebroside), glucosylsphingosine, and potentially other β-glucosides are natural substrates for this enzyme, the more general terms acid β-glucosidase or lysosomal β-glucosidase are preferred to glucocerebrosidase. Acid β-glucosidase (EC 3.2.1.45) will be used in this chapter."

Scriver. "Gaucher Disease, Chapter 146, page 2 (revised July 2010 by Gregory A. Grabowski, Gregory A. Petsko, Edwin H. Kolodny). *Online Metabolic and Molecular Bases for Inherited Disease* (OMMBID).

62311-6 Gaucher disease NBS panel

LOINC Code	LOINC (Analyte) Name	Data Type	Units
62312-4	Gaucher disease newborn screen interpretation	CE	
62313-2	Gaucher disease newborn screen comment-discussion	TX	
55917-9	Acid beta glucosidase [Enzymatic activity/volume] in Dried blood spot	NM/ ST	umol/L /h

New Codes for 5 LSDs Detectable by NBS

Condition Name (and Abbreviation)	SNOMED CT code	LOINC Name for quantitative NBS analyte associated w/ each condition	LOINC Code
Fabry disease (GLA)	16652001	Alpha galactosidase A [Enzymatic activity/volume] in Dried blood spot	55908-8
Gaucher disease (GBA)	190794006	Acid beta glucosidase [Enzymatic activity/volume] in Dried blood spot	55917-9
Krabbe disease (GALC)	192782005	Galactocerebrosidase [Enzymatic activity/volume] in Dried blood spot	62310-8
Pompe disease (GAA)	237968007	Acid alpha glucosidase [Enzymatic activity/volume] in Dried blood spot	55827-0
Niemann Pick disease A/B (ASM)	58459009	Acid sphingomyelinase [Enzymatic activity/volume] in Dried blood spot	62316-5

Quantitative Measures

Quantitative Measures

- Assigned two data types to each of the LOINC codes for quantitative measures
  - NM (numeric) – for pure numeric results
  - ST (string) - to accommodate other characters (e.g. > <)
- The reference range for quantitative results to facilitate interpretation of the results
- UCUM standard for units of measure
  - Avoids Greek symbols (μ) that some systems can't process.
  - Avoids multiple strings for the same unit (μ, u and m for micro), which may cause confusion.
  - {Ratio} for results that are ratios.

Reporting Quantitative Results

- NBS labs should consider reporting all quantitative results with accompanying explanatory information to NBS programs so data is captured for comparison over time
- Also consider sending the quantitative abnormal and equivocal results to the birth institution and attending clinicians, particularly when fixed cutoffs are used
  - Only about 3%* of NBS results are abnormal
  - Quantitative data can help providers interpret the results and provide more information to the family until the infant sees the appropriate specialist or has follow-up testing done

*National Newborn Screening and Genetics Resource Center (NNSGRC). http://genes-r-us.uthscsa.edu/

Customizing HL7 Messages

- Senders can filter on normal/abnormal flags or specific LOINC codes to send specific results or types of results to select categories of message recipients
- Recipients can use the same features to customize the level of detail seen by categories of users

Transitioning to Standard Codes

Transitioning to standard codes: Using both standard and local codes in HL7

- HL7 messages can carry two codes and names for each question/variable and answer
- States that have legacy systems that use local codes can send both local and standard codes
  - This preserves backwards compatibility during the transition from legacy local coding systems to national standard codes.
- OBX-3: Observation ID (e.g., lab test) can carry both:
  - Universal code (LOINC code) and name and Local code and name
- OBX-5: Observation Value (e.g., response when "question" in OBX-3 has a coded answer list) can carry any 2 code-name pairs:
  - SNOMED CT, LOINC answer (LA), or local

Example HL7 Message Segments

Example HL7 OBX (observation) segment: Quantitative screening result for Gaucher disease

OBX|3|NM|55917-9^Acid beta glucosidase [Enzymatic activity/volume] in Dried blood spot^LN^4231^Glucocerebrosidase^L||1.3|umol/L/h|> 4.1|L|||F

*Please note – for purposes of simplicity, the entire HL7 OBR/OBX structure is not shown. For more details, see http://newbornscreeningcodes.nlm.nih.gov/HL7

HL7 Message Panel for Gaucher NBS Results

OBX|1|CE|62312-4^Gaucher disease newborn screen interpretation^LN||LA12431-5^Not normal requiring immediate non-filter paper follow-up for at least one condition ^LN|||A|||F

OBX|2|TX|62313-2^Gaucher disease newborn screening comment-discussion^LN||Abnormal result indicates possible Gaucher Disease and immediate referral to a Metabolic Geneticist is indicated to confirm the diagnosis and begin treatment|||A|||F

OBX|3|NM|55917-9^Acid beta glucosidase [Enzymatic activity/volume] in Dried blood spot^LN^ 4231^Glucocerebrosidase^L||1.3|umol/L/h|>4.1|L|||F

*Please note – for purposes of simplicity, the entire HL7 OBR/OBX structure is not shown. For more details, see http://newbornscreeningcodes.nlm.nih.gov/HL7

HL7 Message Panel for Krabbe NBS Results

OBX|1|CE|62308-2^Krabbe disease newborn screen interpretation^LN||LA6626-1^Normal^LN|||N|||F

OBX|2|TX|62309-0^Krabbe disease newborn screening comment-discussion^LN||Any baby with clinical features suggestive of a metabolic disorder requires clinical and diagnostic follow-up regardless of whether the NBS result is normal or abnormal.|||N|||F

OBX|3|NM|62310-8^Galactocerebrosidase [Enzymatic activity/volume] in Dried blood spot^LN^ 4100^Galactosylceramidase^L||2.4|umol/L/h|>0.5| N|||F

*Please note – for purposes of simplicity, the entire HL7 OBR/OBX structure is not shown. For more details, see http://newbornscreeningcodes.nlm.nih.gov/HL7

Dual observation ID codes and names, and HL7 abnormal flag

- OBX|107|CE|57719-7^Conditions tested for in this newborn screening study [Identifier] in Dried blood spot^LN|99|190794006^Gaucher's disease^SCT ^LA14039-4^GBA^LN|||A|||F

*Please note – for purposes of simplicity, the entire HL7 OBR/OBX structure is not shown. For more details, see http://newbornscreeningcodes.nlm.nih.gov/HL7

Next Steps

- CCHD
- MPS I and MPS II
- Follow Up

Conclusions

- Standardizing NBS results reporting across state programs is critical for information exchange, research, QA, and disaster preparedness.
- The HRSA/NLM guidance allows NBS labs and programs to send and store results in one common, coded format.
- As new conditions and tests are discovered and/or added to the SACHDNC recommendations, we will add new codes and update the guidance.
- If the NBS community requests other changes **based on consensus within the community**, we can easily update existing codes and templates.
- Many states are close to electronic reporting of NBS, and we hope others will soon follow their lead.
  - Join us for HIT Implementation Roundtable Wed 7:30am-8:15am (Spinnaker)

Acknowledgments

State programs and labs

- California
- Colorado*
- Illinois
- Indiana*
- Iowa
- Kentucky
- Massachusetts
- Minnesota
- Missouri
- New York*
- Oregon
- Pennsylvania
- Texas
- Utah*
- Virginia
- Washington

Federal and state agencies and organizations

- HRSA
- CDC
- NICHD
- NIH ORDR
- NNSGRC
- ACMG
- APHL
- PHII
- NBS lab system vendors
- Genetic Alliance
- ...and many more

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Newborn Screening Coding and Terminology Guide

Data Standards for Electronic Reporting

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Thank you!
Any questions?

http://newbornscreeningcodes.nlm.nih.gov

- LOINC NBS panel and annotated sample HL7 message for download
- Links to PHII HL7 Implementation Guides for Orders and Results
- Lists of conditions, associated analytes and their LOINC codes, as well as UCUM and SNOMED CT codes where appropriate
- XML download of coding content
- Updates page with RSS feed

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