



NewSTEPS

A Program of the Association of Public Health Laboratories™

Newborn Screening **QUALITY INDICATORS**

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INTRODUCTION

Newborn screening (NBS) is a public health program that entails many components including testing, diagnosis, follow-up, treatment, education and evaluation. In the United States, over four million newborns receive newborn screening annually. The Secretary’s Advisory Committee on Heritable Disorders in Newborns and Children (ACHDNC) evaluates and recommends disorders to be included on the Recommended Uniform Screening Panel (RUSP). Each state, however, mandates the specific disorders to be tested, implements a screening process including follow-up of out-of-range results, and is responsible for quality improvement of the entire newborn screening system. NewSTEPS has adopted a set of Quality Indicators initially developed by stakeholders from the newborn screening community. NewSTEPS gratefully acknowledges the input of the newborn screening community as well as the Colorado School of Public Health in revising and implementing the Quality Indicators.

QUALITY INDICATORS OVERVIEW

The eight newborn screening Quality Indicators have been developed by representatives from state newborn screening programs and other newborn screening stakeholders and have undergone careful evaluation to assure agreement on definitions. The Quality Indicators will be used to provide longitudinal evaluation of a state program as well as comparisons to aggregate data across programs.

This document provides the purpose and definition of each of the eight quality indicators as well as a glossary of terms that are used throughout the document. Additionally, Appendix B: Laboratory Information Management Systems (LIMS) Helpful Hints is included to provide you with information to aid in the extraction of the quality indicator data from the LIMS and provide guidance in instances of how to collect and report the data points. Information will continue to be added to Appendix B as new information becomes available.

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|----------------------------|--|
| Quality Indicator 1 | Percent of dried blood spot specimens that were unacceptable due to improper collection and/or transport |
| Quality Indicator 2 | Percent of dried blood spot specimens with at least one missing state-defined essential data field upon receipt at the lab |
| Quality Indicator 3 | Percent of eligible newborns not receiving a newborn screen, reported by dried blood spot or point-of-care screen(s) |
| Quality Indicator 4 | Percent of infants that have no recorded final resolution (confirmed diagnosis or diagnosis ruled out by an appropriate medical professional) with the newborn screening program |
| Quality Indicator 5 | Timeliness of newborn screening activities |
| Quality Indicator 6 | Percent of infants with an out-of-range newborn screen result requiring clinical diagnostic workup reported by disorder category |
| Quality Indicator 7 | Percent of disorders detected by newborn screening with a confirmed diagnosis by an appropriate medical professional |
| Quality Indicator 8 | Percent of missed cases, reported by disorder |

Please direct all questions pertaining to Quality Indicators to Careema Yusuf at Careema.Yusuf@aphl.org at (240) 485-2761

General Considerations

- A **first specimen** is the earliest specimen received at the laboratory for testing. All additional specimens received at the laboratory for a given newborn are considered subsequent specimens.
- **Subsequent specimen** refers to any specimen received at the laboratory after the first specimen for the same newborn. A subsequent specimen may be received at the laboratory for:
 - An unacceptable first specimen.
 - A requested repeat specimen for a borderline or out-of-range result from the first specimen.
 - A routine second screen specimen in two-screen states, which occurs after the completion of the first mandated screen and performed on the same newborn within the state defined deadline for the second screen.
 - A requested repeat specimen for the second screen due to borderline, out-of-range or unacceptable second screen specimen.

- b) Number of infants in which a subsequent dried blood specimen was requested for repeat testing following a borderline result from the first dried blood spot specimen that have no recorded final resolution (confirmed diagnosis or diagnosis ruled out by an appropriate medical professional)¹, by 12 months of age, with the state newborn screening program, divided by the number of infants in the state requested to have a subsequent dried blood spot specimen for repeat testing following a borderline result from the first dried blood spot specimen, multiplied by 100.
- c) Number of infants with an out-of-range result from a dried blood spot screen requiring further clinical diagnostic workup by an appropriate medical professional that have no recorded final resolution (confirmed diagnosis or diagnosis ruled out by an appropriate medical professional)¹, by 12 months of age, with the state newborn screening program, divided by the number of infants that had an out-of-range result from a dried blood spot screen requiring clinical diagnostic workup by an appropriate medical professional, multiplied by 100.⁴
- d) Number of infants with an out-of-range result from a critical congenital heart disease (CCHD) screen requiring further clinical diagnostic workup by an appropriate medical professional that have no recorded final resolution (confirmed diagnosis or diagnosis ruled out by an appropriate medical professional)¹, by 12 months of age, with the state newborn screening program, divided by the number of infants that had an out-of-range result from a critical congenital heart disease (CCHD) screen requiring further clinical diagnostic workup by an appropriate medical professional, multiplied by 100.⁴
- e) Number of infants with an out-of-range result from an early hearing detection and intervention (EHDI) screen that have no recorded final resolution (confirmed diagnosis or diagnosis ruled out by an appropriate medical professional)¹, by 12 months of age, with the state newborn screening program, divided by the number of infants that had an out-of-range result from an early hearing detection and intervention (EHDI) screen requiring further clinical diagnostic workup by an appropriate medical professional, multiplied by 100.⁴

Footnotes:

1. For the purposes of QI data collection, short term follow-up ends at the time of diagnosis or by ruling out of a diagnosis.
2. Unacceptable dried blood spot specimens excludes those collected in less than 24 hours [for example Neonatal Intensive Care Unit (NICU) infants].
3. This does not include requested subsequent specimens for repeat testing based on borderline results.
4. Documentation for critical congenital heart disease (CCHD) or early hearing detection and intervention (EHDI) screening should include confirmation that the infant received evaluation by an appropriate medical professional.

QUALITY INDICATOR 5: Timeliness of NBS Activities

Proportion of specimens/screens that were obtained during the following process intervals:

- a) Time from birth to specimen collection/ point-of-care testing.
- b) Time from specimen collection to receipt at your state's newborn screening laboratory.¹
- c) Time from specimen receipt at your state's newborn screening laboratory to reporting out specimen results.
- d) Time from birth to reporting out specimen results.
- e) Time from reporting out-of-range results to medical intervention by an appropriate medical professional for infants with a confirmed clinical diagnosis.
- f) Time from birth to confirmation of clinical diagnosis by an appropriate medical professional.
- g) For infants with an out-of-range newborn screen result requiring a clinical diagnostic workup by an appropriate medical professional, time from birth to determining if a result was a false positive.

Purpose: To identify time components of the newborn screening system that may be shortened in order to shorten the time to identification of infants at risk for newborn screening disorders, thereby decreasing the risk of potential harm to infants who may be identified with a disorder on the newborn screening panel.

Screening Data for Denominators:

- a) The denominators for 5a.i - 5a.v are calculated as the summation of values entered for each of the specified time categories in units of hours from birth to specimen collection/ point-of-care testing:
 - i. Total number of first dried blood spot specimens collected.
 - ii. Total number of reported complete critical congenital heart disease (CCHD) screens.
 - iii. Total number of reported complete early detection and intervention (EHDI) screens.
 - iv. For two screen states, total number of first dried blood spot specimens collected for the second screen.
 - v. Total number of subsequent dried blood spot specimens collected.
- b) The denominators for 5b.i and 5b.ii are calculated as the summation of values entered for the specified time categories in units of days from specimen collection to receipt at your state's newborn screening laboratory:
 - i. Total number of first dried blood spot specimens received at your state's newborn screening laboratory.
 - ii. Total number of subsequent dried blood spot specimens received at your state's newborn screening laboratory.
- c) The denominators for 5c.i – 5c.v are calculated as the summation of values entered for each of the specified time categories in units of days from specimen receipt at your state's newborn screening laboratory to reporting out results:
 - i. Total number of dried blood spot specimens with out-of-range results requiring clinical diagnostic workup by an appropriate medical professional for time critical

- calculated through the summation of values entered for each time category.
- iii. Normal and out-of-range results for all disorders from first dried blood spot specimens: Number of first dried blood spot specimens with a normal or out-of-range result for any disorder reported out in the specified time categories in units of days from birth, divided by the total number of first dried blood spot specimens with a normal or out-of-range result for any disorder. Total number of first dried blood spot specimens with a normal or out-of-range result for any disorder is calculated through the summation of values entered for each time category.
 - iv. Normal and out-of-range results for all disorders from subsequent dried blood spot specimens: Number of subsequent dried blood spot specimens with a normal or out-of-range result for any disorder reported out in the specified time categories in units of days from birth, divided by the total number of subsequent dried blood spot specimens with a normal or out-of-range result for any disorder. Total number of subsequent dried blood spot specimens with a normal or out-of-range result for any disorder is calculated through the summation of values entered for each time category.
 - v. In two screen states, normal and out-of-range results for all disorders from second screen dried blood spot specimens: Number of second screen dried blood spot specimens with a normal or out-of-range result for any disorder reported out in the specified time categories in units of days from birth, divided by the total number of second screen dried blood spot specimens with a normal or out-of-range result for any disorder. Total number of second screen dried blood spot specimens with a normal or out-of-range result for any disorder is calculated through the summation of values entered for each time category.
- e) Time from reporting out-of-range results requiring clinical diagnostic workup by an appropriate medical professional to medical intervention³ by an appropriate medical professional for infants with a confirmed clinical diagnosis:** QI-5e requires infants with a confirmed clinical diagnosis to be entered as a case in the NewSTEPS Repository⁴ with time from reporting out-of-range results to intervention by a medical professional entered in units of days. A table for QI-5e is automatically generated that pulls and aggregates necessary case data from the NewSTEPS Repository. Descriptive statistics generated in the table include: the total number of infants diagnosed with a disorder within the appropriate disorder category; the median time elapsed from reporting out-of-range results to intervention by an appropriate medical professional; and the minimum and maximum time elapsed in units of days. All information in this table is reported by disorder category.⁵
- f) Time from birth to confirmation of clinical diagnosis:** QI-5f requires infants with a confirmed clinical diagnosis to be entered as a case in the NewSTEPS Repository⁴ with time from reporting out-of-range results to intervention by a medical professional entered in units of days. A table for QI-5e is automatically generated that pulls and aggregates necessary case data from the NewSTEPS Repository. Descriptive statistics generated in the table include: the total number of

infants diagnosed with a disorder within the appropriate disorder category; the median time elapsed from birth to confirmation of a clinical diagnosis; and the minimum and maximum time elapsed in units of days. All information in this table is reported by disorder category.⁵

g) For infants with an out-of-range newborn screen result requiring a clinical diagnostic workup by an appropriate medical professional, time from birth to determining if a result was a false positive, with the number of false positives tallied in the following categories, reported by disorder category⁵:

- No false positives called out
 - Less than 7 days after birth
 - 7-14 days after birth
 - 15 days to 1 month after birth
 - Greater than 1 month to 2 months after birth
 - Greater than 2 months to 6 months after birth
 - Greater than 6 months to 9 months after birth
 - Greater 9 months to 12 months after birth
 - Greater than 12 months after birth
 - Time elapsed unknown
- i. Number of infants requiring clinical diagnostic workup by an appropriate medical professional due to an out-of-range result from the dried blood spot screen determined to be a false-positive result in the specified time intervals from birth, reported by disorder category, divided by the number of infants that had an out-of-range result from a dried blood spot screen requiring clinical diagnostic workup by an appropriate medical professional, multiplied by 100.
 - ii. Number of infants requiring clinical diagnostic workup by an appropriate medical professional due to an out-of-range result from the critical congenital heart disease (CCHD) screen determined to be a false-positive result in the specified time intervals from birth, divided by the number of infants with an out-of-range result from a critical congenital heart disease (CCHD) screen requiring clinical diagnostic workup by an appropriate medical professional, multiplied by 100.
 - iii. Number of infants requiring clinical diagnostic workup by an appropriate medical professional due to an out-of-range result from the early hearing detection and intervention (EHDI) screen determined to be a false-positive result in the specified time intervals from birth, divided by the number of infants with an out-of-range result from an early hearing detection and intervention (EHDI) screen requiring clinical diagnostic workup by an appropriate medical professional, multiplied by 100.

Quick Tips

- Time from birth to collection (QI5a) is the only measure collected in the unit of hours. All other measures (QI 5b-d) are collected in the unit of days (i.e. will be an integer in units of whole days).
- Each quality indicator has a designated measure for first, subsequent and routine second screens. Please ensure that you separate out these screens and enter them in the appropriate fields.
- For [time critical disorders](#) (QI5c.i, QI5d.i) and non-time critical disorders (QI5c.ii and QI5d.ii), NewSTEPS does not specify whether these measures should include first specimens, subsequent

specimens, or both. The purpose of this quality indicator is to capture the time it takes to interpret the result or act on that result. For this measure, time intervals should be calculated using the report-out times for the earliest specimen tested that detected the borderline or out-of-range result that led to an infant seeking diagnostic work-up by a medical professional -. *Please note that this is different than the ACHDNC guidelines, which only asks for initial specimens.*

- Calculate time to report out using the **first specimen** if :
 - a. An out-of-range result was detected on the first specimen
 - b. An out-of-range result was detected on the first specimen and confirmed on the subsequent specimen
 - c. A borderline result was detected on the first specimen and an out-of-range result was detected on the subsequent specimen during repeat testing
 - d. A first specimen was unsatisfactory, *tested*, and detected the out-of-range result (i.e. unsatisfactory first specimen detected an out-of-range result).
- Calculate the time to report out using the **subsequent specimen** if the first specimen was unsatisfactory, *not tested*, and the resulting subsequent specimen detected an out-of-range result during repeat testing
- For **two-screen states**, calculate the time to report out using the specimen from which the out-of-range was detected.

Footnotes:

1. In the NewSTEPS Repository, state profiles will gather information on how newborn screening programs define *receipt at laboratory and how this is recorded*: Definition of receipt by lab: a) courier drop off; b) logged in by lab staff (electronic or manual); c) when testing is initiated; or d) Other, please describe. Recording of Specimen receipt by lab: a) Date and time stamp (Gold standard); b) Date stamp; c) Other, please describe.
2. Time Critical Disorders: The following table is from the Secretary’s Advisory Committee on Heritable Disorders in Newborns and Children’s (ACHDNC) recommendations on timeliness in newborn screening and was created based on the Society for Inherited Metabolic Disorders (SIMD) position statement and expert opinion from metabolic geneticists, hematologists, endocrinologist and pulmonologists.

Organic Acid Conditions	Fatty Acid Oxidation Disorders	Amino Acid Disorders	Other Disorders
Propionic acidemia (PROP)	Medium chain acyl-CoA-dehydrogenase deficiency (MCADD)	Argininosuccinic aciduria (ASA)	Classic Galactosemia (GALT)
Methylmalonic acidemia (methylmalonyl-CoA mutase) (MUT)	Very Long chain acyl-CoA dehydrogenase deficiency (VLCADD)	Citrullinemia type-1 (CIT)	Congenital adrenal hyperplasia (CAH)

Isovaleric acidemia (IVA)	Long chain L-3-hydroxyacyl-CoA dehydrogenase deficiency (LCHAD)	Maple syrup urine disease (MSUD)	
3-Hydroxy-3-methylglutaric aciduria (HMG)	Trifunctional protein deficiency (TFP)		
Holocarboxylase synthase deficiency (MCD)			
β -Ketothiolase deficiency (BKT)			
Glutaric Aciduria, Type 1 (GA1)			

3. A definition of medical intervention can be found in Appendix A: Glossary of Terms.
4. Individual cases of early hearing detection and intervention (EHDI) are not collected in the NewSTEPS Repository at this time.
5. A list of disorder categories can be found in Appendix A: Glossary of Terms

QUALITY INDICATOR 6: Percent of infants with an out-of-range newborn screen result requiring clinical diagnostic workup by an appropriate medical professional, reported by disorder category^{1, 2}

Purpose: To determine the percentage of infants with an out-of-range newborn screen result requiring further clinical diagnostic workup by a health care professional, reported by disorder category^{1, 2}.

Screening Data for Denominators:

- a) Number of newborns, born in your state that received a dried blood spot screen whose specimen was received at your newborn screening laboratory.³
- b) Number of newborns, born in your state that received a critical congenital heart disease (CCHD) screen.
- c) Number of newborns, born in your state that received an early hearing detection and intervention (EHDI) screen.

Definitions:

- a) Number of infants with an out-of-range result from the dried blood spot screen requiring clinical diagnostic workup by an appropriate medical professional, reported by disorder category^{1, 2}, divided by the number of newborns, born in your state that received a dried blood spot screen whose specimen was received at your newborn screening laboratory³, multiplied by 100.
- b) Number of infants with an out-of-range result from the critical congenital heart disease (CCHD) screen, requiring clinical diagnostic workup by an appropriate medical professional, divided by the number of newborns, born in your state that received a critical congenital heart disease (CCHD) screen, multiplied by 100.
- c) Number of infants with an out-of-range result from the early hearing detection and intervention (EHDI) screen, requiring clinical workup by an appropriate medical professional, divided by the number of newborns, born in your state that received an early hearing detection and intervention (EHDI) screen, multiplied by 100.

Footnotes:

1. In the NewSTEPS Repository, state profiles will collect information regarding what screening protocols each NBS program uses for NICU infants.
2. A list of disorder categories can be found in Appendix A: Glossary of Terms.
3. All newborns for whom a specimen was received, whether acceptable or unacceptable should be included in this count. This does not include refusals, deaths or blank specimen cards.

QUALITY INDICATOR 7: Percent of disorders detected by newborn screening with a confirmed diagnosis by an appropriate medical professional

- a) Birth prevalence of disorders detected by newborn screening with a confirmed diagnosis by an appropriate medical professional, reported by disorder.
- b) Percent of disorders detected from the first dried blood spot specimen with a confirmed diagnosis by an appropriate medical professional, reported by disorder.¹
- c) Percent of disorders detected from a subsequent dried blood spot specimen with a confirmed diagnosis by an appropriate medical professional, reported by disorder.¹
- d) In two screen states, percent of disorders detected by the second newborn screen with a confirmed diagnosis by an appropriate medical professional physician (dried blood spot test only), reported by disorder.

Purpose: To determine the percentage of each disorder detected by newborn screening for each state.

Screening Data for Denominators:

- a) Number of newborns, born in your state that received:
 - i. A dried blood spot screen whose specimen was received at your state's newborn screening laboratory, reported by disorder. ²
 - ii. A critical congenital heart disease (CCHD) screen.
- b) Total number of infants born in your state with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, reported by disorder.³ This denominator will be automatically generated based on the number of cases entered into the NewSTEPs data repository for a particular disorder.
- c) Total number of infants born in your state with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, reported by disorder.³ This denominator will be automatically generated based on the number of cases entered into the NewSTEPs data repository for a particular disorder.
- d) Total number of infants born in your state with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, reported by disorder.³ This denominator will be automatically generated based on the number of cases entered into the NewSTEPs data repository for a particular disorder.

Definitions: Quality Indicator 7 requires individual infants with a confirmed diagnosis of a disorder on your state's newborn screening panel to be entered as a case in the NewSTEPs Repository. A table is automatically generated that pulls and aggregates necessary case data. Information in the table includes percentages based on the specifications described below. All information in the tables are reported by disorder.¹

- a) **Birth prevalence of disorders detected by newborn screening with a confirmed diagnosis by**

a physician, reported by disorder:

- i. Number of infants with an out-of-range result from a first or subsequent dried blood spot specimen requiring clinical diagnostic workup by an appropriate medical professional and with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, divided by the number of newborns, born in your state that received a dried blood spot screen whose specimen was received at your newborn screening laboratory, reported by disorder.²
 - ii. Number of infants with an out-of-range result from a critical congenital heart disease (CCHD) screen, requiring clinical diagnostic workup by an appropriate medical professional and with a confirmed diagnosis by an appropriate medical professional, divided by the number of newborns, born in your state that received a critical congenital heart disease (CCHD) screen.
- b) Percent of disorders detected by the first dried blood spot specimen for each disorder:** Number of infants with an out-of-range result from the first dried blood spot specimen, requiring clinical diagnostic workup by an appropriate medical professional and with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, divided by the total number of infants born in your state with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, reported by disorder.
- c) Percent of disorders detected by a subsequent dried blood spot specimen with a confirmed diagnosis by an appropriate medical profession, reported by disorder (dried blood spot test only):** Number of infants with an out-of-range result from a subsequent dried blood spot specimen, requiring clinical diagnostic workup by an appropriate medical professional and with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, divided by the total number of infants born in your state with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, reported by disorder.
- d) In two screen states only, percent of disorders detected by the second newborn screen for each disorder (dried blood spot test only):** Number of infants with an out-of-range result from the second dried blood spot screen that did not have an out-of-range result from the first dried blood spot screen, requiring clinical diagnostic workup by an appropriate medical professional and with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, divided by the total number of infants born in your state with a confirmed diagnosis of a disorder on your state's newborn screening panel by an appropriate medical professional, reported by disorder.

Footnotes:

1. Individual cases of early hearing detection and intervention (EHDI) are not collected in the NewSTEPS Repository.
2. All newborns from whom a specimen was received, whether acceptable or unacceptable, should be included in this count. This does not include refusals, deaths or blank specimen



cards.

3. Data are pulled from the cases entered into the NewSTEPS Repository. The denominator is calculated as the summation of all cases from your state with a confirmed diagnosis entered into the repository for each disorder.

QUALITY INDICATOR 8: Percent of missed cases, reported by disorder^{1, 2}

- a) Percent of infants that have a confirmed diagnosis by a physician, but did not have an out-of-range newborn screen result on their valid dried blood spot screen or critical congenital heart disease (CCHD) screen, reported by disorder.³
- b) Percent of infants that have a confirmed diagnosis by a physician, but did not have an out-of-range newborn screen result because they did not have a valid dried blood spot screen or critical congenital heart disease (CCHD) newborn screen, reported by disorder.³

Purpose: To describe how efficiently newborn screening programs are identifying infants with each disorder.

Screening Data for Denominators:

- a) Data are pulled from the cases entered into the NewSTEPS Repository. The denominator is calculated as the summation of all cases with a confirmed diagnosis from your state entered into the repository. The denominator should include both confirmed cases identified by newborn screening *and* not identified by newborn screening.
- b) Number of newborns, born in your state, considered eligible for newborn screening.

Definitions:

- a) Number of infants with a confirmed diagnosis by a physician for a specific disorder, but did not have an out-of-range screen result on a valid dried blood spot or critical congenital heart disease (CCHD) screen, by disorder,³ divided by the total number of infants with a confirmed diagnosis (true positives and false negatives combined), multiplied by 100.
- b) Number of infants with a confirmed diagnosis by a physician for a specific disorder, but did not have an out-of-range screen result because they did not have a valid dried blood spot or critical congenital heart disease (CCHD) screen, by disorder,³ divided by the number of newborns, born in your state, considered eligible for newborn screening, multiplied by 100.

Footnotes:

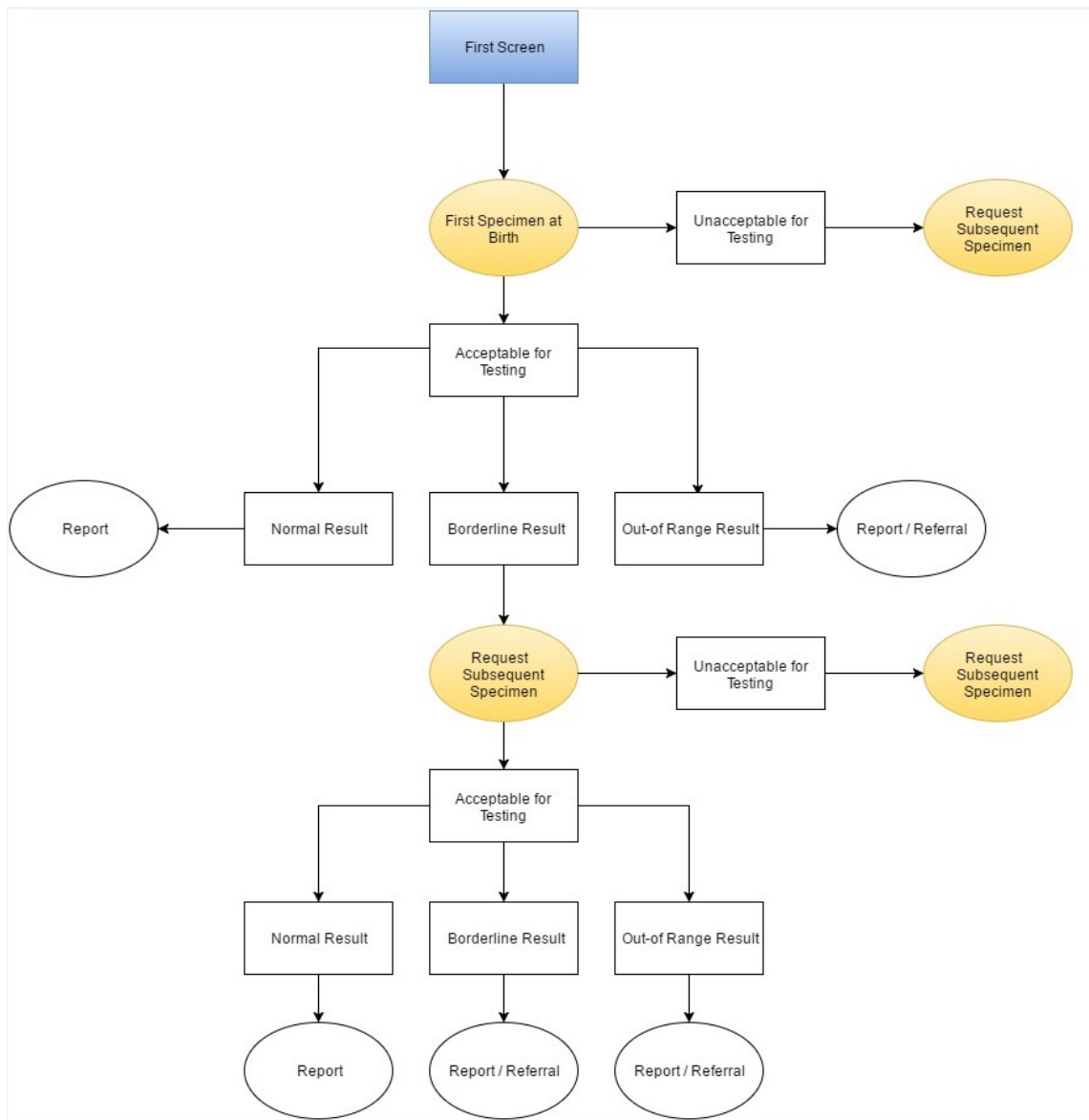
1. This is the number of missed cases known by the state. Additional information for each state will be collected on the state profile to reflect how the NBS program collects information on missed cases (i.e. active surveillance vs. passive surveillance).
2. Follow-up time for missed cases is up to 18 years of age.
3. Individual cases of early hearing detection and intervention (EHDI) are not collected in the NewSTEPS Repository.

Appendix A: Glossary of Terms

- **Borderline Results:** Results derived from the testing of a dried blood spot newborn specimen that require the request of a subsequent dried blood spot specimen for repeat testing.
- **Disorder Categories:** Quality Indicators 5g and 6 are reported by disorder category. Disorder categories are listed below, as are the disorders they encompass:
 - *Organic Acid Disorders:* PROP, MUT, Cbl A,B, IVA, 3-MCC, HMG, MCD, BKT, GA1
 - *Fatty Acid Disorders:* CUD, MCAD, VLCAD, LCHAD, TFP
 - *Amino Acid Disorders:* ASA, CIT, MSUD, HCY, PKU, TYR I
 - *Endocrine Disorders:* CH, CAH
 - *Hemoglobin Disorders:* Hb ss, Hb S/Bth, Hb S/C
 - *Lysosomal Storage Disorders:* Pompe, MPS-I
 - *Other Disorders:* BIOT, CF, GALT, SCID
 - CCHD reported separately
 - EHDI reported separately
- **Eligible Newborn:** Eligibility for newborn screening is based on individual state protocol. This will typically be the number of live births minus those who are not eligible due to death, due to being transferred and screened out-of-state, and for whom screening was inappropriate.
- **Essential Information:** Essential information is defined differently by each state, and consists of information that is critical for specimen testing and follow-up activities. Missing essential information is that which will require additional work by lab staff to obtain. The following is a list of data elements considered essential information from the Emergency NBS Collection Cards¹:

<ul style="list-style-type: none"> ▪ Patient Identification Number ▪ Infant's First Name ▪ Infant's Last Name ▪ Date of Birth ▪ Time of Birth ▪ Date of Specimen Collection ▪ Time of Collection ▪ Birth Weight ▪ Sex 	<ul style="list-style-type: none"> ▪ Mother's First Name ▪ Mother's Last Name ▪ Mother's Address ▪ Mother's Phone ▪ Submitter Identification ▪ Submitter's Address ▪ Physician's Name ▪ Physician's Phone
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- First Screen:** For two screen states, the first screen is the dried blood spot screen performed on the newborn based on the specimen collected closest to the time of birth, but not exceeding the state defined timeline for the second screen (mandated or not). All point-of-care newborn screens are considered first screens. States without a second screen (mandated or not), can only have a first screen.

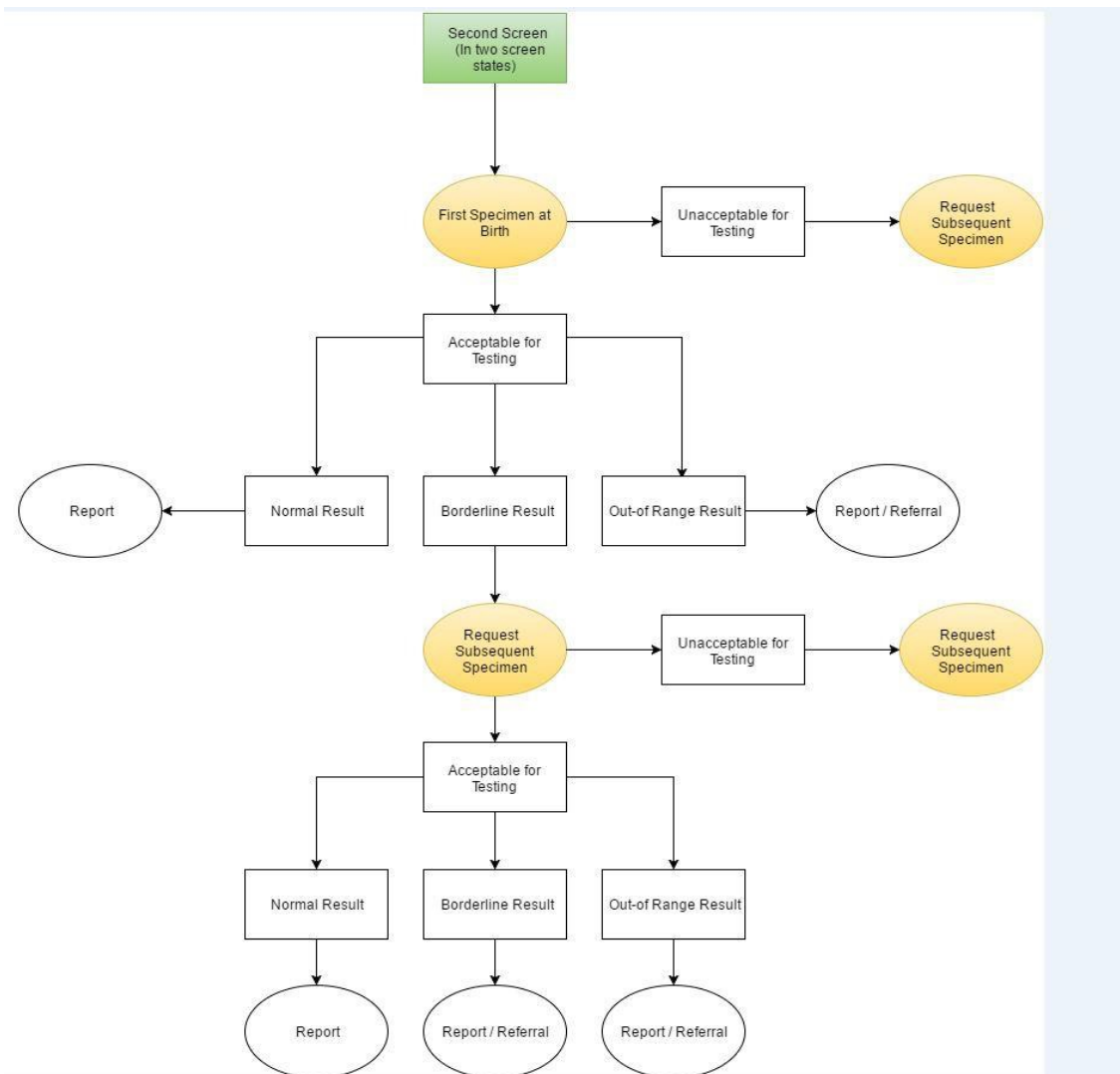


- First Specimen:** The earliest specimen received at the laboratory for a dried blood spot newborn screen. A first specimen can only be received at the laboratory once per screen. All additional specimens received at the laboratory for a given newborn screen are considered subsequent specimens.

- **Improper Collection:** Any specimen that is unacceptable for testing due to collection errors. Examples of improper collection are unacceptable dried blood specimens with insufficient quantity of blood, clotting, smearing or contamination (water, feeding formulas, antiseptic solutions, or powder from gloves or other materials); inadequately filled circles; oversaturation with blood; scratching or abrading by capillary tube spotting; incomplete drying before mailing; and specimens collected on expired dried blood spot cards. Improper collection is defined by Clinical and Laboratory Standards Institute (CLSI).²
- **Improper Transport:** Any specimen received after the state-defined length of time that deems a specimen unacceptable for testing. Any specimen that is damaged in transport (crushed, exposed to water or other liquid, torn, etc.) or specimens placed in a sealed plastic bag without a desiccant should also be considered improper transport. Improper collection is defined by Clinical and Laboratory Standards Institute (CLSI).²
- **Infant:** A baby who is greater than or equal to one month of age and less than 12 months of age.
- **Medical Intervention:** Any interaction by a medical professional with the infant's family that changes the current care for the infant based on the newborn screening results and/or the presumptive diagnosis for a specific disorder. Intervention may occur in a medical setting, or may include changes in care per phone conversations. Examples include advising parents to not let a newborn fast following an abnormal MCADD newborn screen, or initiating antibiotic therapy in the case of an abnormal sickle cell newborn screen. Medical intervention may precede a formal diagnosis and does not include additional newborn screen specimen collection.
- **Monitoring Specimens:** Specimens that are collected and tested throughout the lifespan of an individual with a confirmed diagnosis of a disorder on the newborn screening panel for the purpose of managing and monitoring the severity of the disorder. An example of this is the testing of phenylalanine levels in individuals diagnosed with PKU for the purpose of dietary management.
- **Newborn:** A young child less than one month of age.
- **Out-of-Range Results:** Results derived from a dried blood spot or point-of-care screen that require further clinical diagnostic workup by an appropriate medical provider.
- **Repeat Testing:** A requested subsequent specimen for the purpose of retesting a sample to verify a borderline result from the first specimen for any given newborn screen.
- **Pre-Analytic Error:** Any error occurring prior to the specimen being received at the laboratory that would prevent the newborn from receiving a complete screen using that specimen. For

dried blood spot screens, some examples include: unacceptable specimens that never had a subsequent specimen requested, collected, or received at the laboratory; specimens lost in transit; or specimens for which hospital personnel forgot to either collect or ship the specimen. For point-of-care screens, some examples include: malfunctioning screening equipment; child discharged prior to screen; or misinterpretation of the point-of-care algorithm.

- Second Screen:** For two screen states, the second screen is the dried blood spot screen performed on the newborn collected closest to the state defined deadline for the second screen (mandated or not), and occurring after the completion of the first mandated screen. The second screen may encompass the first specimen collected for the screen, and any subsequent specimens collected for the second screen due to a borderline out-of-range result or unacceptable specimen. *No point-of-care newborn screens are considered second screens.*



- Sample:** In newborn screening, a sample is taken from a newborns blood specimen via hole-

punch and tested for any of the disorders on the newborn screening panel. Multiple samples may be taken and tested from one specimen.

- **Specimen:** In newborn screening, blood drawn from a newborn and placed on a newborn screening card is referred to as a specimen. The blood is referred to as a specimen for the remainder of its existence on the newborn screening card. A sample is then taken from the specimen via hole-punch and tested. Multiple samples may be taken and tested from one specimen.
- **Subsequent Specimen:** Any specimen received at the laboratory for a given newborn screen after the first specimen has been received at the laboratory for the same newborn screen. A subsequent specimen may be received at the laboratory based on a borderline result from the first specimen, or an unacceptable first specimen. There may be multiple subsequent specimens per screen.

Footnotes:

1. Emergency NBS Collection Cards: The card and associated data collection form were designed by the Quality Assurance/Quality Control (QA/QC) Subcommittee of the Newborn Screening and Genetics in Public Health Committee of APHL. The blood collection cards are housed at the Newborn Screening Quality Assurance Program (NSQAP), Division of Laboratory Sciences, National Center for Environmental Health, Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia. NSQAP will be responsible for assuring the performance (i.e. expiration date) of the filter paper during card storage at CDC)
2. Blood Collection on Filter Paper for Newborn Screening Programs; Approved Standard—Fifth Edition. CLSI document LA4-A5 (ISBN 1-56238-644-1). Clinical and Laboratory Standards Institute, 940 West Valley Road, Suite 1400, Wayne, Pennsylvania 19087-1898 USA, 2007).

Appendix B: Laboratory Information Management Systems (LIMS) Hints

Annual Measurement Point of Reference: For the purposes of manually entering or uploading quality indicator data into the NewSTEPS Repository, data will need to be pulled and aggregated from your laboratory and follow-up information systems on an annual basis. The annual time interval used for aggregating data is January 1 – December 31 of each year. If the quality indicator refers to specimens, then all specimens that were received at the laboratory between January 1 and December 31 of the given year should be included in the calculation. If the quality indicator refers to infants, then all infants born between January 1 and December 31 of the given year should be included in the calculation.

For example, a baby in your state was born on December 30, 2012 and the dried blood spot specimen for this newborn was received at your newborn screening laboratory on January 1st, 2013. For all quality indicators using specimens as the unit of measurement, this newborn's specimen would be included in your summation of specimens for the year 2013, even though the baby was born in the year 2012. For all quality indicators using newborns or infants as the unit of measurement, this newborn would be included in your summation of newborns or infants for the year 2012, even though the dried blood spot specimen was received in the year 2013.

The quality indicators that measure specimens and, therefore, use the date the specimen was received at the laboratory as the annual measurement point of reference are:

- Quality Indicators: 1 (a-b), 2, and 5 (a-d)

The quality indicators that measure newborns or infants and, therefore, use the date of birth as the annual measurement point of reference are:

- Quality Indicators: 3 (a-e) 4 (a-d), 5 (e-g), 6, 7 (a-d), and 8 (a-b)

Quality Indicator 1: Any specimens that were unacceptable due to both improper collection and transport should be counted under improper collection only. If it is unknown whether unacceptable specimens were due to either improper collection or transport, they should be counted under improper collection only. Categories used by your newborn screening program for improper collection and improper transport should be communicated to your LIMS vendor, where applicable.

Quality Indicator 2: State-defined essential information that is missing or incorrect is likely to be corrected within LIMS, resulting in the inability to quantify the missing or incorrect data elements. It is recommended that newborn screening programs flag data elements in their LIMS that are initially missing data, as well as tag updated fields with a time stamp to ensure that all data fields

initially missing essential information can be tracked. Additionally, the data fields considered essential information should be communicated to your LIMS vendor, where applicable.

Quality Indicator 3: LIMS systems may not be able to count subsequent specimens if a link does not exist to connect the first specimen with any subsequent specimens for the same newborn. It is recommended that all specimens be matched to a newborn using a universal identifier within the LIMS, and across information systems within the newborn screening laboratory. For two-screen states, it may be helpful to include a checkbox on the newborn screening card with a corresponding variable in the LIMS that indicates whether a specimen is a first specimen, subsequent specimen, or a specimen from a second screen.

Quality Indicator 4: There is complexity with combining data from lab and follow-up information systems. If your state uses the same vendor for both, it is recommended to work with the vendor to develop queries to combine necessary data elements for reporting for Quality Indicator 4. If your state uses a separate vendor for lab and follow-up information systems, we recommend that each vendor work to together to aggregate the data for the purposes of reporting quality indicator data. If this situation applies to your state, please contact Careema Yusuf Careema.Yusuf@aphl.org or with NewSTEPS for more information.

Quality Indicator 5: Updated Categories in Units of Days:

Quality Indicator	(Date – Date) Value	New Category	Reference Date
QI5b (All): Collection to Receipt	0	Same Day (Day 0)	Calendar Day of Collection
	1	Next Day (Day 1)	Calendar Day of Collection
	2	Day 2	Calendar Day of Collection
	3	Day 3	Calendar Day of Collection
	4	Day 4	Calendar Day of Collection
	5	Day 5	Calendar Day of Collection
	6	Day 6	Calendar Day of Collection
	>6	>= Day 7	Calendar Day of Collection
	Missing/invalid	Unknown	Calendar Day of Collection
QI5c (All): Receipt to Reporting	0	Same Day (Day 0)	Calendar Day of Receipt at the Lab
	1	Next Day (Day 1)	Calendar Day of Receipt at the Lab
	2	Day 2	Calendar Day of Receipt at the Lab
	3	Day 3	Calendar Day of Receipt at the Lab
	4	Day 4	Calendar Day of Receipt at the Lab
	5	Day 5	Calendar Day of Receipt at the Lab
	6	Day 6	Calendar Day of Receipt at the Lab
	>6	>= Day 7	Calendar Day of Receipt at the Lab
	Missing/invalid	Unknown	Calendar Day of Receipt at the Lab