Newborn Screening Manual:
A guide for newborn care providers

This manual was created by Newborn Screening Ontario (NSO) as a comprehensive guide for submitting institutions and health care providers (HCPs) to ensure that all infants born in Ontario have high quality newborn screening completed. This manual outlines recommended practices in newborn screening, along with common challenges and solutions.

This manual is available free-of-charge to hospitals and midwifery practices that provide newborn screening. Revised or additional pages of the manual will be distributed periodically to ensure that the information contained is consistent with current practices. The most up-to-date version of the manual is available for download on the NSO website, www.newbornscreening.on.ca.

If you have any questions about the information in this manual, or would like to order additional copies for your hospital/practice, please e-mail newbornscreening@cheo.on.ca.
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1.1 Introduction

Newborn screening is a public health system made up of many different yet integral parts: screening, diagnosis, management, evaluation and education. Founded in 2005, Newborn Screening Ontario (NSO) is based at the Children’s Hospital of Eastern Ontario (CHEO) in Ottawa, Ontario. NSO coordinated the modernization of Ontario’s newborn screening system over the last few years, both in the logistical aspects of how the program is run and in the ability to screen for an increasing number of diseases.

To ensure that the newborn screening system runs smoothly, NSO is responsible for communicating with a multitude of newborn screening stakeholders including the families of infants screened, submitting institutions, practices & health care providers (HCPs), prenatal educators, newborn screening treatment centres, and the Ministry of Health and Long Term Care (MOHLTC). Expanded newborn screening began in April 2006, making Ontario a leader in newborn screening and offering one of the most comprehensive newborn screening programs in Canada.

The primary goal of newborn screening is the early identification of affected infants in time to prevent serious health problems. To do so, every infant must be offered screening. Realizing this goal involves the combined efforts of health care providers across the province.

The purpose of this guide is to ensure that all infants born in Ontario have the opportunity to have high quality newborn screening completed.

This manual outlines:
- recommended practices in newborn screening
- common problems with screening practices
- general information about NSO
- the diseases currently included in the newborn screening panel

While all of the diseases tested for are rare and not usually apparent at birth, collectively over 200 affected infants in Ontario will be found to have one of these diseases every year (~1 in 800 infants born). HCPs can help these children have the best start in life through timely newborn screening, early diagnosis and treatment. The cost of missing one of these diseases is immense, both in human suffering and in financial terms. Untreated infants can develop mental retardation, serious health problems, or even die, sometimes without a diagnosis being made.

Ensuring that every infant born in Ontario is screened and that every affected infant receives appropriate treatment and follow-up requires the coordinated efforts of three main groups of HCPs:

- **Submitters:**
  Hospitals, birthing centres, midwifery practices, and primary HCPs are responsible for parent education about newborn screening, blood specimen collection, point of care testing, providing accurate and complete information for every screened infant, and for prompt follow-up of screen positives for Critical Congenital Heart Disease and in the event a blood sample is unsatisfactory or a screen is missed.

- **Newborn Screening Ontario:**
  NSO is responsible for testing, record keeping, quality assurance of testing, communication with submitters about unsatisfactory or missed screens, referring screen positive infants to a regional treatment centre, obtaining follow-up information on screen positive infants, and providing education about newborn screening to parents, HCPs, and the general public.

- **Regional Treatment Centres:**
  Every screen positive infant is referred to a regional treatment centre or specialist physician. The treatment centre is responsible for ensuring confirmatory testing of screen positive infants, management of confirmed cases, providing NSO with follow-up information, and for education of local HCPs.

In addition, the NSO Advisory Council is an independent advisory body of health and other professionals with expertise in newborn and childhood screening with a mandate to advise the MOHLTC and NSO on its policies and programs related to newborn and childhood screening.
Ontario’s newborn screening system

1.2 NSO history

- **1965** - Screening for Phenylketonuria (PKU) begins
- **1978** - Screening for Congenital Hypothyroidism (CH) begins
- **2005** - Announcement that the provincial newborn screening program will move to the Children’s Hospital of Eastern Ontario (CHEO) in Ottawa and screen for at least 25 additional diseases
- **April 2006** - Newborn screening program operated by NSO adds screening for Medium Chain Acyl-CoA Dehydrogenase Deficiency (MCADD)
- **August 2006** - Screening for 18 additional metabolic diseases begins
- **November 2006** - Screening for hemoglobinopathies (HbSS, HbSC, and HbS/ß-thalassemia) begins
- **February 2007** - Screening for Biotinidase deficiency and Galactosemia begins
- **May 2007** - Screening for Congenital Adrenal Hyperplasia (CAH) begins
- **April 2008** - Screening for Cystic Fibrosis (CF) begins
- **November 2010** - Carrier results for some hemoglobinopathies (HbS, HbC, HbD, HbE) available by parent/guardian request
- **August 2013** - Screening for Severe Combined Immune Deficiency (SCID) begins
- **2017** - Screening for Critical Congenital Heart Disease (CCHD) begins
- **December 2017** - C5OH related diseases removes from the NSO Screening Panel
1.3 NSO contact information

NSO can be contacted in several ways:

- **Phone**: Toll-Free: 1-877-NBS-8330 (1-877-627-8330)
  Local: 613-738-3222
- **Fax**: 613-738-0853
- **Email**: newbornscreening@cheo.on.ca
- **Mail**: Newborn Screening Ontario
  415 Smyth Road
  Ottawa, Ontario, K1H 8M8
- **Website**: www.newbornscreening.on.ca
- **Twitter**: @NBS_Ontario
- **YouTube**: www.youtube.com/user/NBSOntario
- **Our office hours are Monday to Friday, 8:00 - 16:00**

To request a newborn screening report:

- Fax request to 613-738-0853
- Fill out an online request on the NSO website
- Please include with your request at least 3 identifiers (health card number, name, date of birth, mother’s maiden name, etc.) as well as your telephone and fax numbers.

For amended reports (to provide us with missing or correct information):

- Amended report voice mailbox (checked daily)
  613-738-3222 x3180

To order newborn screening cards and shipping supplies:

- Please see Section 2: Ordering newborn screening supplies

Frequently asked questions (and many valuable resources for HCPs, parents, and the public):

- www.newbornscreening.on.ca

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### Bulletins:

NSO sends updates to submitters primarily via email bulletins.

For an archive of all bulletins see the NSO website:

- www.newbornscreening.on.ca

To be added to the bulletin mailing list, send an email with your name, institution, role (i.e. nurse, lab, shipping and receiving), email, fax and phone number to:

- newbornscreening@cheo.on.ca

Please notify NSO if your contact information changes so that the most up-to-date information is in the NSO contact database.

### 1.4 Newborn screening essentials

#### 10 important points to remember about newborn screening

1. **Please use the term “Newborn Screen.”** The term “PKU test” is confusing to parents. PKU (or phenylketonuria) is only one of the diseases targeted by Newborn Screening Ontario. For a complete and current list of the diseases screened for, please visit our website.

2. **The incidence** of all the newborn screening diseases is now about **one infant in 800**, over 200 new cases each year in Ontario (~3-4 infants/week identified).

3. **Screen every infant.** Newborn screening detects rare diseases that are not apparent at birth. Most affected infants do not have a family history of the disease; therefore every infant is at risk.

4. **Screen every infant prior to discharge from hospital.** Infants discharged prior to 24 hrs of age should have a blood sample taken **prior to discharge**. Inform parents of the need and process for a repeat screen. If an **infant is transferred to another hospital**, ensure there is communication between hospitals regarding the responsibility for performing the newborn screening. Send the blood sample to NSO as soon as possible. CCHD screening can only be performed after 24 hours of age. If an infant is discharged prior to 24 hrs of age ensure that the parents know they need to return for CCHD screening.
5. **Goal of Newborn Screening: Diagnose and treat in early life.** If undetected and untreated these disorders may cause mental retardation, serious health problems, or even death. Early detection and treatment can greatly improve the outcome for these infants and sometimes even save their life.

For example, infants with PKU and congenital hypothyroidism irretrievably lose significant cognitive function if phenylalanine and thyroid stimulating hormone (TSH) are not under control by three weeks of age.

6. **A) A positive screen does not mean an infant is affected with a disease:**
   - Diagnostic testing must be done to confirm or rule out a disease

**B) A negative screen does not rule out a disease:**
   - Any infant symptomatic of a disease should have the appropriate diagnostic evaluation immediately

7. **Newborn screening is standard of care and is strongly recommended for all infants, but is not mandatory.** Ensure that you have thoroughly explained newborn screening to all parents. If parents do not consent to testing, it is extremely important to document the refusal in the infant’s records, or use the decline form provided by NSO.

8. **Unsatisfactory blood samples require a repeat sample immediately.** The submitting institution or midwifery practice that took the initial sample is responsible for ensuring the repeat sample is done, even if the infant has been discharged. Delays in obtaining a repeat sample can lead to delayed diagnosis and serious health problems in affected infants.

9. **Ensure that the newborn screening cards are filled out completely and accurately.** All requested information is essential for accurate interpretation and follow-up of results. Incorrect or missing information can lead to false positive results and unnecessary testing for healthy infants.

10. **Visit the Newborn Screening Ontario website:**
    [www.newbornscreening.on.ca](http://www.newbornscreening.on.ca)

1.5 **Newborn screening timeline**

**Before birth**

As a provider of antenatal or newborn care, you should discuss newborn screening with your patient. Information about newborn screening should also be discussed with prospective parents in their prenatal education classes. To assist with parent education, pamphlets about newborn screening are available in many different languages and can be downloaded from the NSO website.

**After delivery**

A newborn screening blood spot collection card (Appendix 1) should be completed between one day (24 hours) and seven days after the birth of the infant, ideally, between one day (24 hours) and two days (48 hours) after birth. If tested before 24 hours of age, the test should be repeated within 5 days (eg. at the first postnatal checkup). Blood spots from infants are collected using the heel-prick method, which is detailed on the back of the card. Screening for CCHD via pulse oximetry screening should be done between 1 day (24 hours) and 2 days (48 hours) after birth for well infants, and up to seven days after birth for infants admitted to an NICU. The parent should be given the parent information sheet (Appendix 2) that includes a reference number in the top right hand corner. This number can be used to link to the infant’s sample and results.

A HCP will fill out demographic information about the infant and the infant’s parent/guardian along with the results of the infant’s pulse oximetry screening, on the newborn screening card. This information allows NSO to correctly interpret the infant’s results, and, in the event that the infant screens positive for a disease, it will allow the HCPs coordinating follow-up to contact the parent/guardian quickly to retrieve the infant.

As a HCP, it is important that you emphasize to parents/guardians that newborn screening is part of their infant’s routine care and could save their infant’s life and/or prevent serious health problems. The vast majority of parents agree to have their infant screened. Parents/guardians may choose to decline newborn screening for their infant. You should discuss this decision with them, and you should document this decision in the infant’s medical record. Some HCPs will ask parents/guardians to sign a form indicating that they have refused newborn screening for their infant. NSO has created a decline form that is a part of the newborn screening requisition. This form is not mandatory but is available for you to use (Appendix 2b).
The newborn screening blood sample

It is critical that NSO receive the newborn screening card as soon as possible after the blood is collected. Therefore, the cards should be sent no later than 24 hours after collection and, ideally, as soon as the blood spots are dry (at least 3 hours after collection). Infants with some of the diseases screened will start to become ill and may suffer irreversible damage soon after birth. DO NOT BATCH SAMPLES FOR TRANSPORTATION.

The hospital or HCP will send the infant’s sample to NSO using the pre-paid courier system. When the sample is received, the blood spot is tested and the demographic information from the newborn screening card is entered into a database. This database links the infant’s information with the results of the screening tests, and also serves as a way to store the infant’s newborn screening result.

The results of the screening tests are reviewed by physicians and/or laboratory scientists to determine if the infant has a lower risk of having a disease (“screen negative”) or a higher risk of having a disease (“screen positive”).

1.6 Newborn screening results

Screen negative results (low risk)

If the infant is “screen negative”, he or she has a low risk of having any of the diseases included on the screening panel. In this case, a report (Appendix 3) is mailed to the hospital or health care provider that submitted the infant’s sample. Screen negative pulse oximetry results should be recorded on the newborn screening card and sent to NSO.

Unsatisfactory blood sample

If the infant’s blood sample is unsatisfactory (for example, if it was taken too early, or if there was not enough blood to do the testing), NSO will contact the hospital or HCP that sent in the sample and ask them for a new sample (Appendix 6). The HCP who submitted the sample should call the parent/guardian to tell them that the infant’s test needs to be repeated and make arrangements for another sample to be taken.

Screen positive results (increased risk)

If the infant is screen positive, this does NOT mean that the infant has a disease; however, it does mean that the infant has an increased chance to have a disease. For screen positive results on a blood sample, an NSO physician will refer the infant to physicians at a Regional Treatment Centre (RTC) for follow-up diagnostic testing to determine if the infant truly has the disease (Appendix 4). In some cases, NSO staff work directly with HCPs and families to arrange testing. Screen positive pulse oximetry results require immediate clinical follow-up.

The physician caring for the infant following a screen positive result will provide the referring physician at NSO with follow-up information about the infant, as is the case for any medical referral. This includes medical information, which tests were done, the results of those tests, and whether or not the infant truly has the disease (Appendix 4).

This feedback allows NSO to make sure that screen positive infants receive appropriate and timely care. NSO HCPs review this information and may contact you, the family, or the regional treatment centre if we have questions about the infant’s care. Parents/guardians may choose not to share this information, in which case, they should be encouraged to discuss this with their HCP or contact NSO.

Screening limitations

As with all screening tests, false positive and false negative results occur in newborn screening. False positives may increase parental anxiety, while false negatives will give a misleading sense of reassurance. If an infant in your care displays symptoms of a particular disease, the child should be investigated and managed appropriately regardless of newborn screening results. The relevant specialist should be contacted immediately for further advice.

There is wide variation in the clinical presentation of the diseases that newborn screening detects. Therefore, some affected individuals – infants who have had diagnostic testing indicating that they have a particular disease – will remain asymptomatic or have very mild symptoms, even without treatment.
1.7 List of diseases screened for in Ontario

<table>
<thead>
<tr>
<th>Test</th>
<th>LIS Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amino Acidemias:</strong></td>
<td></td>
</tr>
<tr>
<td>• Phenylketonuria and Variants / Bipterin defects</td>
<td>NBS-PKU</td>
</tr>
<tr>
<td>• Maple Syrup Urine Disease</td>
<td>NBS-MSUD</td>
</tr>
<tr>
<td>• Homocystinuria (Hypermethioninemias)</td>
<td>NBS-HCY</td>
</tr>
<tr>
<td>• Citrullinemia / Argininosuccinic Aciduria</td>
<td>NBS-CIT</td>
</tr>
<tr>
<td>• Tyrosinemias</td>
<td>NBS-TYR</td>
</tr>
<tr>
<td>• Amino Acidopathies, other</td>
<td>NBS-AA</td>
</tr>
<tr>
<td><strong>Organic Acidemias</strong>:</td>
<td></td>
</tr>
<tr>
<td>• Propionic / Methylmalonic Acidemias</td>
<td>NBS-C3</td>
</tr>
<tr>
<td>• Isovaleric Acidemia / 2 Methylbutyric Acidemia</td>
<td>NBS-C5</td>
</tr>
<tr>
<td>• Glutaric Acidemia Type 1</td>
<td>NBS-C5DC</td>
</tr>
<tr>
<td><strong>Fatty Acid Oxidation Defects:</strong></td>
<td></td>
</tr>
<tr>
<td>• Medium Chain Acyl Co-A Dehydrogenase Deficiency / Glutaric Acidemia Type 2</td>
<td>NBS-MCAD</td>
</tr>
<tr>
<td>• Very Long Chain Acyl CoA-Dehydrogenase Deficiency</td>
<td>NBS-VLCAD</td>
</tr>
<tr>
<td>• Long Chain Hydroxyl Acyl Dehydrogenase / Trifunctional Protein Deficiencies</td>
<td>NBS-LCHAD</td>
</tr>
<tr>
<td>• Carnitine Uptake Defect</td>
<td>NBS-CUD</td>
</tr>
<tr>
<td>• Fatty Acid Oxidation Disorders, other</td>
<td>NBS-FA</td>
</tr>
<tr>
<td><strong>Galactosemia</strong></td>
<td>NBS-GALT</td>
</tr>
<tr>
<td><strong>Biotinidase Deficiency</strong></td>
<td>NBS-BIOT</td>
</tr>
<tr>
<td><strong>Endocrine Disorders:</strong></td>
<td></td>
</tr>
<tr>
<td>• Congenital Hypothyroidism</td>
<td>NBS-CH</td>
</tr>
<tr>
<td>• Congenital Adrenal Hyperplasia</td>
<td>NBS-CAH</td>
</tr>
<tr>
<td><strong>Sickle Cell and other Hemoglobinopathies</strong></td>
<td>NBS-HGB</td>
</tr>
<tr>
<td><strong>Cystic Fibrosis</strong></td>
<td>NBS-CF</td>
</tr>
<tr>
<td><strong>Severe Combined Immune Deficiency</strong></td>
<td>NBS-SCID</td>
</tr>
<tr>
<td><strong>Critical Congenital Heart Disease</strong></td>
<td>NBS-CCHD</td>
</tr>
</tbody>
</table>

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3 Methylcrotonic / Hydroxymethylglutaric / Methylglutaconic / 2-Methyl, Hydroxybutyric Acidemias and β-Ketothiolase Deficiency were removed from the NSO Screening Panel on December 4, 2017.
2.1 Ordering newborn screening blood spot collection cards

VWR International provides logistics and distribution services for the blood spot collection cards. To order an appropriate supply of cards through VWR you will need to provide the following information:

- **Account number**
  If you do not have an account number, please contact NSO.

- **Catalogue number and quantity desired for blood spot cards**
  Note: Cards come in packs of 25 – Cat# = 89013-658 CHEO 903 BLOOD COLLECT FORM

- **Relevant contact and shipping information**
  For example: your name, department and location in the hospital or practice.

There are several ways you can order your cards from VWR:

- **Phone** 1-800-932-5000
  You will need a purchase order number for tracking purposes. If you do not have access to a formal purchase order number, please create one and keep a record of it.

- **Fax** 1-800-668-6348
  Fax your order on your own form to this number and be sure it contains the information as specified above.

- **Website** [www.vwrcanlab.com](http://www.vwrcanlab.com)
  You need to create a profile by clicking the Register button on the left hand side of the site. You’ll need your account number to do this and it may take up to 3 days before you receive final notification that your web account has been established.

If you have any problems with ordering or need any further information please contact us.

2.2 Ordering shipping supplies from Purolator

Newborn screening samples are transported to NSO using the courier services of Purolator.

- **Website** Sign into your Purolator account at [www.purolator.com](http://www.purolator.com) and select “Order Shipping Supplies”. You may then order your supplies free of charge.

- **Phone** 1-888-744-7123 extension 1

2.3 Purolator downtime procedures

In the event of Purolator downtime, NSO will send a bulletin detailing how to ensure that sample transportation is not compromised.

2.4 Ordering pulse oximetry supplies

Information regarding pulse oximetry equipment and supplies can be found in the CCHD section of NSO’s website.
3.1 Definition

You, as a submitter, are integral to the newborn screening process. You are responsible for parent education, specimen collection, pulse oximetry testing and following up on screen positives for CCHD, unsatisfactory samples and missed newborn screens. In following the recommended newborn screening practices, you are helping save the lives of over 200 infants in Ontario every year.

3.2 Who is responsible for ensuring that the screening tests are performed?

It is a responsibility of perinatal and newborn HCPs to ensure that all infants born in Ontario are offered newborn screening tests.

For infants born in hospitals, ensuring tests have been offered/performed should be part of the pre-discharge check list.

For infants born at home under the care of a Registered Midwife, ensuring that tests have been offered/performed should be part of the first or second postpartum visit.

3.3 Information for parents/guardians

It is important that antenatal HCPs and prenatal educators discuss newborn screening with prospective parents. Pamphlets in multiple languages are available through the MOHLTC free of charge.

Each newborn screening card has an information letter that should be given to parents before the heel prick and pulse oximetry tests are performed (Appendix 2). This letter includes a serial number that links to their infant’s sample and results in the NSO database, NSO’s phone number and the NSO website address. The NSO and MOHLTC websites provide additional information for parents and HCPs.

3.4 Parental/guardian right of refusal

Newborn screening is not currently mandated by law, however, it is considered standard of care. The vast majority of parents agree to have their infant screened.

As with many standard medical practices, there is no formal province-wide mechanism to document consent. However, NSO and the MOHLTC have taken many steps to provide education to ensure information is available to parents to make informed decisions for their infants. It is important that parents/guardians are made aware that newborn screening could save their infant’s life and/or prevent serious health problems.

Parents may decline screening, and HCPs should discuss this decision with them to ensure they are making an informed decision. HCPs should document this decision in the infant’s medical record and/or have the parents/guardians sign a form indicating they have refused this testing for their infant.

NSO has created a decline/deferral form that is a part of the newborn screening card (Appendix 2b). This form was designed as a tool to help your practice but is not necessary if you have an alternative method to document declines.

3.5 Responsibility for documentation

Submitters are responsible for ensuring all of the fields on the newborn screening requisition are completed BEFORE it is sent to NSO.

A number of submitters in Ontario have instituted a “quality control check” where each newborn screening card is reviewed by the charge nurse, unit clerk or laboratory staff to ensure it has been fully completed prior to being sent to NSO.
3.6 Completion of the newborn screening card

The newborn screening card consists of five parts: the filter paper for specimen collection, the CCHD information section, the requisition, the decline/defer section, and the parent information sheet.

The newborn screening card should be completed using a ball point pen. If a hospital stamp or sticker is used, all copies of the card must be stamped/stickered. Please ensure that stickers are printed properly such that critical information is not missing or illegible.

It is recommended that the newborn screening card be completed prior to collection to minimize the potential for sample mix-up.

It is the submitter’s responsibility to document in the infant’s chart or medical record the date and time the newborn screening blood sample was collected as well as the date and time of measurement and results of pulse oximetry screening. Many larger submitters keep a central log with this collection information to facilitate communication with NSO.

If the blood sample is collected before 24 hours of age, please check the “<24 hours/early discharge” box on the requisition.

Expiration date

Check the expiration date of the newborn screening card located in the upper right hand corner of the card next to the image of an hourglass, under the circles for the blood. The expiration date is in a year-month format (i.e. 2018-05). If the blood spot collection card has expired, use another card for blood specimen collection.

If you only have expired cards, order new cards immediately. In the meantime, collect newborn screening samples on the expired cards. NSO tests all samples received on expired cards; however, the sample is considered unsatisfactory and a repeat sample will be required.

If you identify newborn screening cards as expired, please return them to NSO where they will be used for other purposes, such as educational initiatives. Please send the expired card(s) to NSO via the same transportation system used to send the newborn screening samples.

Infant information

The newborn screening requisition portion of the blood spot collection card must be completed to ensure proper specimen labeling for positive identification of the infant from whom the specimen was taken.

All fields on the newborn screening requisition should be filled in as completely as possible. A complete newborn screening report cannot be issued if certain critical fields are not completed.

Parent/guardian information

Please fully complete the parent/guardian’s demographic information section on the newborn screening requisition. This includes name, date of birth, address and phone number. This information is critical as it is used to locate an infant in the event of a positive screen.

Children’s Aid Society (CAS)

If the infant is in CAS care, please check the box for “CAS Care” on the newborn screening requisition portion of the card. Please provide the infant’s caseworker’s name and contact phone number in the demographic section, as he/she is the person that will be contacted in the event of a positive screen.

Adoption

If the infant is being adopted, please check the box for “Adoption” on the newborn screening requisition portion of the blood spot collection card. Include the adoptive parent’s information in the demographics section, as they will be caring for the infant and will be the person to contact in the event of a positive screen.
Ordering Health Care Provider and submitting facility

Ordering Health Care Provider:
Each newborn screening sample must have an ordering HCP in order to be in compliance with provincial health care regulations. This individual must be either a physician or midwife.

Some larger submitters have identified one physician who oversees the entire newborn screening process and is listed as the ordering HCP on all samples. Other submitters indicate the physician on-call at the time the sample was obtained.

Submitting facility:
Please also complete the address of the submitting hospital/midwifery practice where the newborn screening report should be sent.

Infant’s Health Care Provider after discharge
Please list the name, address and phone number of the physician/midwife/nurse practitioner in the community that will be caring for the infant after discharge. This information is critical in helping locate an infant in the event of a positive newborn screen.

At this time NSO only sends a copy of the newborn screening report to the submitter. Additional copies are not automatically forwarded to primary HCPs by NSO.

Newborn screening results are available in the Ontario Laboratory Information System (OLIS).

24 hour clock
Please ensure that all times are given using the 24 hour clock. If you do not use the 24 hour clock, please ensure the am/pm section of the requisition is clearly indicated.

3.7 Inadequate documentation – potential harms

The potential adverse impact of missing and/or inaccurate demographic information on the interpretation of an infant’s specimen can have very serious consequences.

Inaccurate provision of the date of birth and/or collection can lead to an infant screening negative for conditions on the panel when truly affected (false negatives), or screening positive when they are not truly affected (false positives). Both scenarios place unnecessary burden on the infant, their family and the health care system.

Failure to indicate that in infant has had a transfusion could lead to an infant screening negative for a subset of disorders on the panel when they are truly affected.

Failure to provide an accurate birth weight and/or feeding status can lead to difficulty interpreting results and ultimately delays in identifying a truly affected infant.

Inaccurate completion of the parent/guardian’s information and/or primary health care provider’s contact information can lead to delays in locating an infant who has screened positive – and subsequent delays in the initiation of treatment.

Inaccurate demographic information on the infant (e.g. incorrect Ontario Health Card Number) can lead to infant misidentification and/or prevent our database from linking multiple specimens on the same infant together.

Incorrect or inaccurate provision of pulse oximetry results can lead to unnecessary follow-up calls and inaccurate indicators of screening quality. NSO has no way of verifying CCHD screening is complete if the information is not provided on the card.
(Page intentionally left blank for printing purposes.)
Premature or very low birth weight infants

Premature or very low birth weight (VLBW) infants may have a delayed rise in TSH even if they have Congenital Hypothyroidism (CH). As NSO uses elevation of TSH as the screening marker for CH, there is an increased risk of a false negative result (missed case) if these infants are screened only once in the early neonatal period. Premature or VLBW infants also have a higher false positive rate for Severe Combined Immune Deficiency (SCID) screening. It is therefore important that screening samples are taken as outlined below and in the flow chart that follows.

**4.1 Timing of specimen collection**

**Full term infants**

A newborn screening sample should be collected between one day (24 hours) and seven days after the birth of the infant. The ideal time to obtain the newborn screen is between one day (24 hours) and two days (48 hours) after birth.

**Infants discharged early (<24hrs)**

A newborn screening sample should be taken on every infant prior to discharge from hospital. If this happens before 24 hours, parents/guardians should be informed that a repeat newborn screen after 24 hours must be done and be informed how to obtain a repeat screen for their infant. The repeat should be performed within 5 days of the initial sample.

Not all diseases are reliably detected using blood samples taken before 24 hours of age. Samples obtained at less than 24 hours of age are considered unsatisfactory and a repeat sample will be requested. The health care provider who submitted the initial sample is responsible for ensuring a repeat sample is collected. NSO recommends that each submitter develop a process to obtain repeat samples for these infants. HCPs should document all correspondence with parents/guardians and/or primary health care providers in the infant’s medical record.

**Tips:**

- Some submitters across Ontario provide parents/guardians with a follow-up appointment at the time of discharge to obtain a repeat sample if the initial sample was obtained at less than 24 hours of age.
- Maintaining a log of infants that require a repeat newborn screen helps submitters ensure repeat samples are collected and facilitates communication with NSO.

*Screen positive results on samples collected at less than 24 hours of age: Specimens collected at less than 24 hours of age, while unsatisfactory, are still analyzed by NSO. If the results are “screen positive” for any disease NSO will initiate appropriate follow-up. A repeat newborn screen is also required to in order for newborn screening to be complete.*
Premature or Very Low Birth Weight Infants +/- PRBC Transfusions

Samples collected from infants greater than 7 days of age

Samples taken from infants who are greater than 7 days of age are analyzed.

As the levels of many screening markers drop over the first week of life, these lab results are checked manually to minimize the risk of missing an affected child (false negative results).

Transfused infants

For the purpose of newborn screening, a transfusion is defined as receipt of packed red blood cells (PRBC). You may indicate “no” for transfusion status on the newborn screening requisition if an infant has only received fresh frozen plasma (FFP) and/or platelets.

If possible, it is best to take the newborn screen prior to a blood transfusion. If the sample is not obtained before transfusion, the health care provider should wait 48-72 hours before a first screening specimen is collected.

Blood transfusions are known to affect the results of screening for the hemoglobinopathies and galactosemia. Infants who are affected with one of these disorders may be missed if they have a transfusion prior to their screen because the donor blood interferes with the screen.

If an infant has a blood transfusion prior to their newborn screen, a repeat sample should be obtained 4 to 6 months after their most recent transfusion (Appendix 5).
Infants transferred to another facility

A newborn screening sample should be taken prior to discharge from the birth hospital. If transfer occurs <24 hours or a newborn screening sample was not taken at the birth hospital, this information should be included in the discharge summary and the receiving hospital should collect the newborn screening sample. Clear communication between the two hospitals involved is essential to ensure the newborn screen is taken.

4.2 Procedure for blood spot specimen collection

Specimen quality

The primary goal is to ensure the quality of blood spots collected from newborns. Unacceptable and poor quality specimens place a burden on the screening system, and cause unnecessary trauma to the infant and anxiety to the infant’s parents. Poor quality specimens can potentially delay the detection and treatment of an affected infant, and could contribute to a missed or late diagnosed case. When NSO receives an unacceptable specimen, it requests another specimen from the submitting hospital or midwifery practice. The turnaround time for analytic results is critical to initiate treatment in time to prevent the adverse consequences of the disease (such as irreversible mental retardation or death).

Specimen acceptability

NSO only declares a specimen unsatisfactory if its analysis might yield unreliable, misleading, or clinically inaccurate values for one or more analytes. In these cases NSO notifies the submitter immediately so that a new sample can be collected as soon as possible. NSO assumes responsibility for the reliability of the analytic values of every specimen we test.

Preliminary steps

Ensure that the blood dot card is not expired.

Complete the required demographic information on the requisition portion of the blood spot collection card. A ballpoint pen should be used; soft-tip pens will not copy through to the other sheets of paper. Address imprint devices (or adhesive labels) may be used if the patient information is not obscured and the blood collection area is not compromised. Do not use printers that might compress the paper.
Confirm the identity of the infant and ensure accuracy of the demographic data on the card. Avoid touching the area within the circles on the filter paper section of the card before, during, and after blood spot collection. Do not allow water, feeding formulas, antiseptic solutions, glove powder, hand lotion, or other materials to come into contact with the card before or after use.

Pain relief for infants
Newborn screening may be a painful procedure for infants. Breastfeeding, kangaroo care (skin-to-skin contact with a parent), and glucose all reduce an infant’s pain. Allow parents to choose a method of pain relief for their infant.

Blood collection on filter paper
Collect the required number of uniform blood spots (currently 5). Do not reapply blood in a partially filled circle as this may result in layering. Each of the five 11 mm circles on the DBS card requires approximately 75 ul to 100 ul of blood to fill.

Heelstick (method of choice)

Precautions
Wash hands vigorously before proceeding. Use all appropriate precautions, including wearing powder-free gloves and changing gloves between infants. Put used lancets in a biohazard container for sharp objects.

Follow local recommendations regarding use of latex gloves in situations of latex allergy.

Site preparation
Warming the newborn’s heel, the skin-puncture site, may help increase blood flow. A warm, moist towel or commercial heel warming device at a temperature no higher than 42°C may be used to cover the site for three minutes. This technique increases the blood flow sufficiently and will not burn the skin. In addition, positioning the infant’s leg lower than the heart will increase venous pressure. (Caution: Topical anesthetic creams such as EMLA should not be used as they may cause vasoconstriction and may also produce analytic interferences.)

Cleaning the site
The skin in the area of the puncture site should be disinfected with alcohol (isopropanol/water: 70/30 by volume, “70%”). Allow the skin to air dry.

Puncture
To obtain sufficient blood flow, puncture the lateral aspect of the infant’s heel on the plantar surface with a sterile lancet or with a heel incision device. The incision device provides excellent blood flow by making a standardized incision 1.0mm deep by 2.5 mm long.

Any puncture device used should be selected so that the puncture does not exceed 2.0 mm in depth. For infant safety, scalpel blades or needles must not be used to puncture the skin for blood collection. Disposable skin puncture lancets of different designs are commercially available for performing the heel stick on infants. For worker safety, disposable skin puncture devices that protect the user from unintentional self-inflicted skin punctures are preferable.

In small, premature infants, the heel bone (calcaneus) might be no more than 2.0 mm beneath the plantar heel skin surface and half this depth at the posterior curvature of the heel. Studies indicate that for some infants (including full-term infants) a puncturing depth beyond 2.0 mm might be excessive and might cause bone damage. Puncture site depth should not exceed 2.0 mm.

Unacceptable sites for NBS blood collection:
- Arch or central area of an infant’s foot
- Fingers of a newborn
- Earlobe
- A swollen or previously punctured site as accumulated tissue fluid may contaminate the specimen
- Uncleared intravenous lines

Direct application
After the heel has been punctured, wipe away the first drop of blood with a sterile gauze pad or cotton ball. Allow a second large blood drop to form by intermittently applying gentle pressure as the drop of blood forms. Touch the filter paper gently against the large blood drop and, in one step, allow a sufficient quantity of blood to soak through and completely fill a preprinted circle on the filter paper. Do not press the filter paper against the puncture site on the heel. Blood should be applied
only to one side of the filter paper. Both sides of the filter paper should be examined to assure that the blood has uniformly penetrated and saturated the paper to the other side.

After blood has been collected from the heel of the newborn, the foot should be elevated above the body, and a sterile gauze pad or cotton swab pressed against the puncture site until the bleeding stops.

**Milking**

Excessive milking or squeezing the puncture site may cause hemolysis of the blood or result in a mixture of tissue fluids with the specimen that can adversely affect test results.

**Layering**

Do not apply layers of successive blood drops to the same printed circle. Applying successive drops of blood to already partially dried spots causes “layering” and inaccurate blood volume collection, which results in non-uniform analyte concentrations and invalidates the specimens.

### 4.3 Collection of newborn screening specimen by other means

#### i. Capillary tube

Although not the method of choice, specimens can be obtained by applying blood to the newborn screening card, which has been collected in sterile, anticoagulant-free capillary tubes. The capillary tube collection method may also apply to blood collected from other sources and transferred onto filter paper.

The use of anticoagulants should be avoided during the collection of the newborn screening sample. Ethylenediaminetetraacetic acid (EDTA) may cause interference with some laboratory tests. Since heparin is a known inhibitor of the Polymerase Chain Reaction (PCR) it should be avoided as it may result in test failure in some circumstances.

**Collection**

Using a fresh sterile, plain (additive-free) capillary tube for each circle to be filled on the blood spot collection card, collect the appropriate volume of blood (each of the five 11 mm circles requires approximately 75-100 uL) required for the newborn screen.

Touch the tip of the capillary tube to the blood drop formed at the heel puncture site. Allow blood to flow into the tube by capillary action. Fill rates might be improved by holding the tube in a near-horizontal position when touching to the blood drop. Collect enough blood to fill all the circles.

**Application**

After filling the capillary tube, immediately apply the contents of that tube to the center of a single, preprinted circle on the filter paper, completely filling the circle. Waiting too long before application will allow cells and plasma to separate or the blood to clot.

To avoid damaging the filter paper fibers, do not allow the capillary tube to touch the filter paper. Actions such as “colouring in” the circle, repeated dabbing around the circle, or any technique that might scratch, abrade, compress, or indent the paper should not be used.

**Do not reuse capillary tubes.**

Apply blood to only one side of the filter paper. Do not apply multiple capillary specimens to the same circle, since caking or heterogeneous spreading will occur and might adversely affect test results.

After blood has been collected from the heel of the newborn, the foot should be elevated above the body, and a sterile gauze pad or cotton swab pressed against the puncture site until the bleeding stops.

#### ii. Dorsal hand vein

Although not the method of choice, blood collected from needle puncture of the dorsal hand vein and its application directly onto the preprinted circles of the filter paper is possible. Blood should not be drawn from an extremity into which IV fluids (including blood) are being or have been infused unless appropriate precautions are taken.
The routine practice of dorsal hand vein collection is discouraged. Problematic issues include:

- Test results might be affected by blood from different vessel sources
- Hand veins might be needed for IV fluids
- Venous sampling is more invasive than a heel stick

Collection and application

Select the appropriate sized winged blood collection set (butterfly). Remove or shorten catheter length so blood can flow freely onto the circle on the filter paper. Use standard pediatric venous collection procedures.

Syringe collection of blood for application onto a blood spot collection card is not recommended because time delays may allow for clot formation and settling of cells producing heterogeneous specimens since anticoagulants are not used.

iii. Umbilical Venous Catheter (UVC) or Umbilical Arterial Catheter (UAC)

Although not the method of choice, blood collected from umbilical catheters (venous or arterial) is acceptable in certain situations (e.g., sick infants or in very low birth weight infants). Although unknown, it is reasonable to expect that there might be some difference in analytic test results between blood taken from the heel and that collected by umbilical catheters.

Collection and application

Due to the fact that UAC or UVC are often used to infuse medications, it is important that blood (e.g., 2 to 2.5 cc [mL] depending on the specifications of the catheter) be drawn from the line in order to clean it before the blood is collected for testing purposes.

After cleaning the line, collect blood in an anticoagulant-free syringe and immediately apply appropriate volumes to the printed circles on the blood spot collection card. It is important that the blood transfer be as quick as possible to avoid blood clotting that might invalidate the specimen for testing.

4.4 Specimen handling

Drying

After application to the blood spot collection card, avoid touching or smearing the blood spots.

Allow the blood specimen to air dry at an ambient temperature of 15°C to 22°C, on a horizontally level, non-absorbent, open surface for at least three hours.

Keep the specimen away from direct sunlight (indirect room light is not usually detrimental unless accompanied by heat).

Blood spots on the filter paper should not be heated, stacked, or allowed to touch other surfaces during the drying process.

Stacking

Since leaching (cross-contamination) between specimens might occur, specimen-to-specimen contact is not appropriate. The DBS card used by NSO includes a fold-over paper attachment to protect the specimens.

Once the blood is fully dried, the cards may be stacked (without rotation of the cards) for specimen transportation.

4.5 Most common errors in specimen collection

NSO frequently notes the following errors:

1. Missing critical data fields (e.g. missing date of collection or date of birth)
   - Please ensure all fields on the card are completed prior to sending the sample to NSO
2. Entering in the incorrect date of collection when a sample is collected close to midnight
   - Please use extra caution when completing the date of collection if the sample is collected close to midnight
3. Entering the mother’s health card number into the infant’s health card number field
   - If the infant does not have a health card number please leave this field blank
4. Utilizing expired blood cards
   - Prior to obtaining the sample, please check that the blood spot collection card is not expired.
4.6 Specimen transport

Samples should be sent to NSO every business day and Saturdays (for sites with access to Saturday pickup). Please do not wait several days to send in the newborn screening sample. Delays could have serious consequences for affected infants and may render the sample unsatisfactory, requiring a repeat newborn screen and further delaying the process. Samples shipped on Friday should have “Saturday Delivery” selected.

Samples should be shipped using the Purolator courier service. NSO has provided a Purolator account for each site for purpose of shipping newborn screening samples. These accounts should only be used for packages destined to Newborn Screening Ontario. Newborn screening samples should be shipped using the tear-proof, water resistant Purolator Express Packs. When creating a shipment at www.purolator.com make sure to select the service option of “Purolator Express Pack”. NSO’s contract with Purolator ensures samples arrive by 8am if this service option is chosen.

DO NOT BATCH NEWBORN SCREENING SAMPLES OVER SEVERAL DAYS. It is critical that NSO receives the newborn screening samples as soon as possible after the blood spots are collected. Once dried (at least 3 hours after collection), the cards should be shipped NSO. Courier pickup can be scheduled daily (Monday-Saturday).

Samples received at NSO greater than 14 days after collection are unsatisfactory, however, they will be analyzed. Screen positive results will be reported. The quality of the results cannot be assured due to possible sample degradation resulting from the length of time since collection and a repeat sample is required.

4.7 Specimen tracking system

Submitters are encouraged to develop an internal system to track that each infant born at their institution has a newborn screen performed. This system should also be used to confirm that a result is received for each sample sent to NSO.

To track specific samples in transit, enter the newborn screening form number found at the top of the collection card in the “tracking reference” field when creating your Purolator shipment.

4.8 Clinical signs or family history of a disease

It must be emphasized that NSO is a screening facility. Therefore, if an infant is experiencing clinical symptoms of a particular disease on the screening panel, diagnostic testing should be initiated immediately.

It is not appropriate to send a dried blood spot specimen to NSO for diagnostic testing unless discussed in advance with the Scientific and Medical Staff at NSO.

4.9 Recommendations for quality assurance

(adapted from the North Dakota Department of Health3)

1. Implement a process for ensuring that a newborn screening test is done
2. Designate individuals responsible for:
   a. Filling in the newborn screening card
   b. Specimen collection
   c. Recording the collection in the infant’s chart
   d. Sending the specimen to NSO
   e. Ensuring test results are received and entered into the infant’s chart
3. Establish procedure for:
   a. Ensuring specimen collection prior to discharge was actually done
   b. Informing parent or guardian for need of repeat testing if the initial specimen was collected prior to 24 hours or after a blood transfusion
   c. Testing under special circumstances (preterm infant, transfer, etc.)
   d. Documentation should a parent or guardian refuse testing
4. Implement a process for ensuring that HCPs and staff are informed of their responsibilities in the newborn screening process
5. Implement the guidelines for specimen collection in this handbook along with those in the Clinical and Laboratory Standards Institute’s “Blood Collection on Filter Paper for Neonatal Screening Programs”4
5.1 Unsatisfactory specimens for specimen quality reasons

Each specimen received at NSO is reviewed for specimen quality and quantity. Repeat samples are requested for all unsatisfactory specimens.

A satisfactory newborn screening specimen

The blood must fully soak through to the back of the filter paper. No areas of white should be visible on the front or back of the circle.

It is estimated that 75 uL – 100 uL of blood is required to fill one circle on the filter paper.

The newborn screening test calculations assume that the blood is evenly distributed within the circle and completely saturates both sides of the filter paper.

3.2 mm diameter punches are taken from the blood spot specimens to be used in the newborn screening tests.

Specimens may be deemed unsatisfactory for the following reasons:

i. Quantity of blood insufficient

The specimen appears sufficient from the front but is insufficient when viewed from the back.

Both sides of the filter paper should be examined to assure that the blood has uniformly penetrated and saturated the paper.

Please do NOT apply blood to both sides of the card.

Failure to collect the appropriate number of blood spots may result in the specimen being unsatisfactory for analysis due to insufficient blood.
ii. Blood spots appear scratched or abraded

If you are using a capillary tube or butterfly to collect the blood specimen, do not allow the capillary tube or butterfly to touch the filter paper to avoid damaging the filter paper fibers. Actions such as “colouring in” the circle, repeated dabbing around the circle, or any technique that might scratch, abrade, compress, or indent the paper should not be used. Do not use the infant’s heel to attempt to force the blood through to the back side of the blood spot collection card. This may damage the fibres of the filter paper leading to inaccurate blood volume collection.

iii. Blood spots are wet and/or discoloured

Do not allow water, feeding formulas, antiseptic solutions, glove powder, hand lotion, or other materials to come into contact with the specimen card before or after use. Ensure that the infant’s heel is dry and free of alcohol prior to performing the heel stick. Ensure that the specimen is dry before shipping.

iv. Blood spots are supersaturated

Repeated application of blood in the same area or supersaturation of the filter paper may lead to an excess volume of blood being analyzed during testing, potentially resulting in false negative or false positive screening results.

v. Spots appear diluted

Ensure that the puncture site is clean and dry before collecting the specimen. Protect the specimen during the drying process.

vi. Blood spots exhibit serum rings

Excessive milking or squeezing the puncture may cause hemolysis of the specimen or result in a mixture of tissue fluids with the specimen which can adversely affect the test result.

vii. Blood spots appear clotted or layered

Applying successive drops of blood to already partially dried spots causes “layering” and inaccurate blood volume collection, which results in non-uniform analyte concentrations.

viii. Blood spots were damaged or delayed in transit

The blood spot collection cards arrived in a wet/damaged envelope.

ix. EDTA contamination

NSO analyzes all samples for the presence of EDTA. If EDTA is detected, the sample is unsatisfactory and a repeat is required.
5.2 Unsatisfactory specimens due to missing demographics

The newborn screening requisition portion of the newborn screening card must be completed to ensure proper specimen labeling for positive identification of the patient.

All fields on the newborn screening card should be filled in as completely as possible. A complete newborn screening report cannot be issued if certain critical fields are not completed.

NSO occasionally receives samples that contain the demographic information of two different infants. In these cases NSO requires a repeat newborn screening sample on both infants, to ensure that both infants have had a satisfactory newborn screen.

Critical fields

Please ensure that the following fields on the newborn screening requisition are completed:

- the infant’s last name,
- the infant’s date of birth,
- the date of specimen collection,
- the date of transfusion (if applicable),
- birth weight,
- Parent/Guardian information,
- the Submitting Health Care Provider,
- gestational age.

Note: The time of the infant’s birth and the time of the collection of the newborn screening specimen are only considered critical fields if the date of collection is one day after the date of birth.

5.3 Disease specific unsatisfactory samples

NSO endeavors to test every blood sample we receive. Occasionally instrument failures occur that require samples to be re-tested. When there is an insufficient quantity of blood to re-test, that sample may be unsatisfactory for testing for a specific disease or diseases. In this case only partial results are available and a repeat specimen is required (Appendix 8 - TLU report addendum).

5.4 Who is responsible for obtaining a repeat specimen?

It is the submitter’s responsibility to obtain a repeat specimen once notified of an unsatisfactory specimen. The submitter should attempt to communicate the need for a repeat specimen directly to the infant’s family or HCP.
5.5 NSO procedure for tracking repeat specimen requests

NSO informs the submitter of the unsatisfactory specimen and a need for a repeat specimen by fax on the day of sample receipt. If a repeat specimen is not received 3 weeks following notification, NSO sends a repeat request letter to the submitter (Appendix 6). Communication attempts to the family and/or HCP by the submitter regarding the need for a repeat sample should be documented on the repeat request letter, which is faxed back to NSO.

The repeat request letter permits NSO to clearly identify whether or not the family and/or HCP has been informed of the need for a repeat. In addition, after an additional 21 days, a letter is sent to parents IF a submitter/practice indicates they have been unable to contact the infant’s family OR if the infant’s HCP has been contacted but no repeat specimen has been received (Appendix 6). A copy of this letter is cc’d to the submitting institution and the infant’s HCP (if known).

Please see the attached documents:

1. Repeat request letter (Appendix 6)
2. Parent letter to send IF parents have not been successfully contacted directly by the submitting institution OR if HCP has been informed but no repeat has been received (Appendix 6)
3. Test Level Unsat Report (Appendix 8)
6.1 What is CCHD?

Congenital Heart Disease (CHD) and Critical Congenital Heart Disease (CCHD) refers to a group of heart defects that occur with the heart structure or greater vessels of the heart, that interfere with effective circulation of oxygenated blood to the body. CHD is the most common congenital malformation, and timely diagnosis impacts mortality, morbidity and overall outcome. CCHD involves more severe diseases and requires early interventions, including surgery and/or catheterization to optimize health outcomes.

CHD occurs in 12 per 1000 live births. Twenty-five percent of CHD cases are CCHD and require surgery or catheter intervention in the first year of life. Malformations account for more infant deaths than any other congenital defects, and CHDs are the leading cause of birth defect-associated infant illness and death.

6.2 Diagnostics: how to identify CCHD

There are several different ways to identify CCHD. About half of CCHD diagnoses are obtained through prenatal ultrasound. Some types of CCHD present with the physical signs mentioned above, which are identified on the postnatal physical examination; however, many infants with CCHD have no clinical signs before decompensation. Infants with CCHD often appear normal or are asymptomatic during their hospital stay and at the time of discharge.

Pulse oximetry screening

Pulse oximetry screening is an additional method to detect CCHD. Pulse oximetry screening should be used IN COMBINATION with prenatal ultrasound and postnatal physical exam to identify infants with CCHD. Using multiple modalities to screen for CCHD means that there is a better chance of capturing these infants before they deteriorate and get sick. Infants identified early receive interventions that lead to better outcomes.

6.3 Primary targets of CCHD screening

The primary targets of CCHD screening are the “Cyanotic Seven” diseases. Pulse oximetry screening may also pick up other heart malformations and non-cardiac causes of cyanosis.

The Cyanotic Seven

- Hypoplastic left heart syndrome
- Pulmonary atresia with intact septum
- Total anomalous pulmonary venous return
- Transposition of the great arteries
- Truncus arteriosus
- Tetralogy of Fallot
- Tricuspid atresia

Secondary targets

- Coarctation of the aorta
- Double outlet right ventricle
- Ebstein's anomaly
- Interrupted aortic arch
- Single ventricles

Additional non-cardiac causes of cyanosis potentially identified by CCHD screening

- Infection
- Persistent Pulmonary Hypertension of the Infant (PPHN)
- Respiratory Illnesses
6.4 Pulse oximetry screening

A pulse oximeter is a medical instrument that measures the amount of oxygen that is carried by hemoglobin. A pulse oximeter measures the colour of the blood flowing through the capillaries of the skin and analyzes it, expressing it as a percentage of saturation (for example, fully saturated hemoglobin would be SpO2 100% or Saturation, pulse, of Oxygen 100%). Because the blood is pulsating, a heart rate can also be obtained through pulse oximetry.

A pulse oximeter has a probe with both a light emitter and a light detector. The probe is applied to the skin so the light can shine through, and be reflected off the red blood cells in the capillaries. The light is received by the detector and the monitor can convert the reading into a number or percentage saturation.

**Probe placement: pre-ductal vs post-ductal**

Probe placement is important. Thinner tissue with capillary beds close to the skin's surface makes it easier for the probe to read the blood colour. The emitter and the detector must be directly opposite each other for an effective reading.

For CCHD screening the required site placement is the RIGHT hand and either foot. The RIGHT hand is PRE-DUCTAL. This means that the blood that flows to the right hand leaves the aorta before the ductus arteriosus. Either foot is a post-ductal site, as the blood flow to the lower extremities leaves the aorta after the ductus arteriosus. This blood may be mixed with blood from the pulmonary vessels through the ductus arteriosus if the ductus has not closed, resulting in lower oxygen levels.

**Screening after 24 hours is recommended as the ductus is most likely closed at this point. Thus a difference in oxygen levels pre-ductally and post-ductally warrants further investigation.**

**Signal reliability**

There are a few different methods to ensure the monitor is relaying an accurate reading (some are specific to the brand and model of monitor, and will have manufacturer-specific instructions).

**In order to obtain an accurate reading, ensure that:**

- The initial and regular maintenance and quality assurance of the monitor is complete and up to date;
- The infant is calm and not moving excessively, the probe placement is secure (light emitter and receptor are aligned);
- There is an even, regular pleth line waveform (movement and unstable signals will give an irregular, ‘dancing’ line);
- There is an audible, regular heart rate (unstable signals or movements may elicit an irregular audible beat);
- The number reading is steady (not jumping around and somewhat random in nature) and consistent with other heart rate monitors.

**Factors that affect SpO2**

To obtain an accurate pulse oximetry measurement, the infant should be in a warm, calm, non-fussing state.

**The factors below can affect SpO2 measurement:**

- Perfusion: well-perfused tissue will be read more effectively by the monitor. The capillary bed refill time is ideally 2-3 seconds; however, the monitors recommended for CCHD screening should still function in low perfused tissue.
- Temperature: The infant’s temperature should be within normal range (36.5° -37.5° Celsius). A cooler temperature can affect the perfusion to the extremities, thus affecting the saturation reading.
- Phototherapy lights: the pulse oximetry probe emits a light that passes through the tissue and is picked up by a detector piece. Phototherapy light can interfere with the detector and disrupt the reading of the oxygen saturation. Please turn off phototherapy lights prior to conducting the CCHD screen. Resume the treatment once the screen is complete.
- Movement of the limb: The pulse oximeter reads by picking up the flow of blood through an arterial pulse. While the monitors are required to be motion tolerant, the reading is most reliable when the limb is still. Try bundling the infant once the probe is applied to ensure a reliable reading.
• Probe placement: The probe should be applied to the thin part (non-thumb side) of the right hand or the thin part (outer aspect) of the foot. The light emitter and the light detector should be facing each other to ensure the signal can be received.

6.5 Best practices for CCHD screening

Parent education

It is the responsibility of the health care provider performing the pulse oximetry screen to educate parents about CCHD screening. This should include informing parents that CCHD screening is a recommended standard of care.

Parents should be informed that pulse oximetry screening is a safe, quick and painless test that measures oxygen levels in the blood. Screening is important because it can help to identify infants with CCHD before they have symptoms. The probe for measuring is like a Band-Aid that wraps around the hand or foot and results will be available immediately.

Parents have the right to refuse the screen. Please document this refusal on the CCHD portion of the DBS card and forward to NSO.

Timing of the screen

The recommended window for CCHD screening is 24-48 hours of age, with an optimal window of 24-36 hours of age. Screens performed prior to 24 hours of age have been shown to demonstrate a higher false positive rate than screens performed after 24 hours because transitional cardiovascular changes that occur during the initial hours of life may be incomplete (closure of the ductus arteriosus).

Screening may occur after the recommended window of 24-48 hours for NICU/SCN babies, if clinically appropriate (normal vital signs, no ventilation support, no supplemental oxygen) up to 7 days of age. As the majority of CCHD will present prior to 7 days of age, there is little value to screening after this time (see NICU/SCN guidelines).

Screening methodology

The pulse oximetry screen compares two separate oxygen saturation measurements at pre-ductal and post-ductal sites. The pulse oximeter probe should be positioned on the RIGHT hand for a pre-ductal oxygen saturation measurement (SpO2) and on EITHER foot for a post-ductal oxygen saturation measurement (SpO2). The light emitter portion of the pulse oximetry probe should be aligned facing the photodetector portion of the pulse oximetry probe.

Measure the saturations from the two sites consecutively, the first measurement directly followed by the second measurement. It makes no difference which site is first, but consider beginning with the site that disturbs the infant the least.

Conduct the screen using a motion tolerant pulse oximeter approved by or provided by NSO. The infant should ideally be in a quiet, non-fussing state. Complete the screen prior to any invasive procedure or care activity that disturbs the infant. Once a reliable signal is obtained (this will be evident using confidence indicators specific to the monitor), observe the oxygen saturation (SpO2) values for 30 seconds and note the highest SpO2 value achieved. If the number fluctuations substantially or episodes of desaturation are noted, the clinical condition of the infant should be evaluated. NEVER ignore the rest of the clinical picture.

6.6 Documentation

The health care provider who performed the screen must document the value of each SpO2 measurement and the evaluation of the CCHD screen result on the CCHD portion of the newborn screening card and in the infant’s chart or medical record. The screening card should be sent to NSO following the usual procedures for shipping blood spot cards. The CCHD portion and blood spot portions of the NSO card ideally stay together, but if this is not possible please ensure both pieces are sent to NSO.

6.7 Evaluation of pulse oximetry results

The pre- and post-ductal values are compared using the algorithm or the evaluation chart to determine the screening.

In order to pass (screen negative):
  • Both values must be over 90, (If a value is below 90, the infant must be referred immediately)
  • at least one of the values must be 95 or over, and
  • the difference between the 2 values must be 3% or less
NSO ADAPTED CCHD SCREENING ALGORITHM
Completed on well infant at 24-48 hours of age or before discharge if less than 7 days old

INITIAL SCREEN
- SpO2 Less than 90% in right hand or either foot
- SpO2 90-94 in right hand and either foot OR Difference is More than 3%
- SpO2 95% or Over in right hand or either foot AND Difference is 3% Or less

IN ONE HOUR
SECOND SCREEN
(IF REPEAT RESULT OBTAINED IN INITIAL SCREEN)
- SpO2 Less than 90% in right hand or either foot
- SpO2 90-94 in right hand and either foot OR Difference is More than 3%
- SpO2 95% or Over in right hand or either foot AND Difference is 3% Or less

IN ONE HOUR
THIRD SCREEN
(IF REPEAT RESULT OBTAINED IN SECOND SCREEN)
- SpO2 Less than 90% in right hand or either foot
- SpO2 90-94 in right hand and either foot OR Difference is More than 3%
- SpO2 95% or Over in right hand or either foot AND Difference is 3% Or less

SCREEN POSITIVE (REFER)
SCREEN NEGATIVE (PASS) NO FURTHER ACTION NEEDED

Document on the blood spot card appropriately and forward to Newborn Screening Ontario
Evaluation chart

If the infant does not pass on the first pulse oximetry screen and has both saturations above 90, repeat the screen in one hour. This is considered a "repeat" result. If a "repeat" result is obtained a second time (with both values over 90), repeat the screen again in one hour. If a pass result is not obtained on the third attempt, the infant should be referred to a physician for further investigation.

When evaluating the saturation values, do not ignore the rest of the clinical picture. CCHD pulse oximetry is a screening process, intended to be completed on well infants. If an infant is demonstrating clinical symptoms, assessment and evaluation must begin immediately.

Screening results

Screen negative (Pass)
The infant is screen negative if the pulse oximetry is greater than or equal to 95% in the right hand or either foot with less than or equal to 3% difference in oxygen saturation between the right hand and foot. No further screening is required.

Screen positive (Refer)
The infant must be referred to a physician immediately if:
- the pulse oximetry is less than 90% in the right hand or either foot at any stage of screening
- the pulse oximetry is less than 95% on both extremities

Submitter
When the infant has a screen positive result, the most responsible provider is to be notified of the screen positive result. In addition, the infant should be referred to a physician for further investigation.

6.8 Screen positive (Refer) result responsibilities

The physician should perform a physical exam of the infant including a four limb blood pressure, femoral pulses, full vital signs and pre- and post-ductal saturations. The physician may also order diagnostic investigations including an ECG, chest X-Ray and other tests to rule out other non-cardiac causes. If cardiac diagnosis cannot be confidently ruled out, NSO recommends consultation with a paediatric cardiologist or paediatrician/neonatologist for further investigation.

If an infant has a screen positive result in an out of hospital environment, an urgent consultation to a physician for assessment should be arranged by the infant’s most responsible health care provider.

Newborn Screening Ontario

When a screen positive result is received by NSO, NSO will call the health care providers involved in the infant’s care to ensure that appropriate follow-up occurred. NSO will complete a Diagnostic Evaluation Report Form (DERF) for the infant, documenting the interventions, outcome, and diagnosis (as information is available) (Appendix 9).

Remember

after 24 hrs | 2 steps or sites | 3 chances

6.9 Exceptions

Infants admitted to an NICU

Infants admitted to the NICU/SCN/PICU and discharged home before 7 days of age will have CCHD pulse oximetry screening completed during their hospitalization when appropriate (no respiratory distress or cardiac symptoms) OR at the time of discharge.

Infants admitted to NICU/SCN/PICU and discharged home after 7 days of age who have not had CCHD screening completed will not undergo CCHD screening at discharge.
Early discharge (less than 24 hours)

Infants that are discharged home from hospital prior to 24 hours of age are considered to be discharged early. They will not have a CCHD pulse oximetry screen prior to discharge but will either have the screen performed by their midwife on an outpatient basis (in their home) during the recommended window of 24-48 hours of age, or return to the hospital or other care facility for a CCHD pulse oximetry screen when the infant is 24-48 hours of age. It is the responsibility of the discharging hospital to arrange the CCHD screen. Organizations should develop their own internal process to handle these cases.

Common errors in CCHD screening

- Using the left hand instead of the right (pre-ductal site)
- Using the right and left hand instead of the right hand and either foot
- Algorithm misinterpretation, screening protocol errors
- Not waiting for a reliable signal prior to getting a reading
- Inappropriate timing for the screen (before 24 hours, or after 48 in a well infant)

Prenatal diagnosis or diagnosis during initial 24 hours

Infants that have a prenatal diagnosis of a CHD or have been diagnosed during their initial 24 hours with a CHD will not undergo a CCHD pulse oximetry screen.

Infants transferred to another hospital

If transfer occurs before 24 hours, or a CCHD screen was not completed during the recommended window because the infant was not stable from a cardio-respiratory perspective, this information should be included in the discharge summary. Clear communication between the two hospitals is essential to ensure that the CCHD screen can be completed when and if appropriate.

6.10 Unsatisfactory CCHD pulse oximetry screens

The screen will be considered unsatisfactory if:
- The algorithm was not followed
- The timing of the screen was not within the recommended window of 24-48 hours for a well infant
- The screening protocol was not followed
- Screening results on the CCHD card were incomplete or incorrect
- Demographics on the CCHD card were incomplete or incorrect

In the case of an unsatisfactory screen where the infant may be at risk, NSO will call the organization where the screen was performed to follow up on the unsatisfactory result and determine if follow-up is required. NSO may recommend that the organization perform a complete CCHD screen or a physical exam of the infant.

6.11 Recommendations for quality assurance

Quality management responsibilities for CCHD pulse oximetry screening are shared between organizations conducting the screening and NSO. Organizations that are screening are responsible for performing ongoing maintenance of pulse oximeters in accordance with NSO recommendations and providing pulse oximetry screening education and ongoing competency evaluation for health care professionals conducting the CCHD screen.

Suggested training for health care providers

Initial competency

Health care providers must be familiar with performing and interpreting the results of pulse oximetry testing. Organizations should provide health care provider pulse oximetry training sessions. Health care providers must be able to demonstrate accurate measurement, interpretation, and documentation of pulse oximetry results. NSO created a free eLearning module to assist with CCHD education.

www.newbornscreening.on.ca/cchdmodule/story.html

Maintenance of competency

Every individual who performs pulse oximetry testing should undergo an annual review. Health care providers should perform a minimum of twelve CCHD screens per year, or complete an eLearning module or training session to reinforce the concepts of CCHD screening.
7.1 Definition

Since January 26, 2012, newborn screening results have been transmitted to the Better Outcomes Registry & Network (BORN - www.bornontario.ca). On a daily basis, BORN notifies NSO of infants with a birth encounter who are 7 days of age or older and where there is no record of a sample at NSO. The NSO team then follows up with the birth hospital or midwifery practice to determine why an infant has not had a newborn screen. This is to reduce the number of missed newborn screens and improve care for newborns in Ontario.

If you receive a call and/or fax from NSO regarding a potential missed screen, please:

- Investigate why this infant had not yet had a newborn screen
- Complete the faxback form right away
- For true missed newborn screens, have the family return to have the newborn screen done as soon as possible

7.2 Common reasons for missed newborn screens

NSO has identified several common reasons for missed newborn screens. These include:

- Delayed: sample taken but not sent OR sample collection delayed OR batched sample sending
- Newborn screen declined by family
- Infant born in hospital and discharged to midwifery care (both providers failed to collect the newborn screen)
- Not taken in error
- Inter-hospital transfer (both hospitals failed to collect the newborn screen)

7.3 Who is responsible for following up on a potential missed screen notification & obtaining the newborn screen when it has been missed?

It is the responsibility of the hospital where the infant was born OR the midwifery practice caring for the mother and infant to investigate why the newborn screen has not been taken and obtain a specimen if the screen has been missed. The submitter should attempt to communicate the need for a specimen directly to the infant’s family or HCP.

7.4 NSO procedure for tracking potential missed newborn screens

NSO informs the responsible hospital/midwifery practice of the potential missed newborn screen and a need for a specimen by phone and fax by sending a Potential Missed Newborn Screen Alert (Appendix 7). Communication attempts to the family and/or HCP, should be documented on the Potential Missed Newborn Screen Alert, which should then be faxed back to NSO.

The Potential Missed Newborn Screen Alert permits NSO to clearly identify the reason for the potential missed screen. If a specimen is not received 2 weeks following notification of a missed screen and NSO has not received documentation that the family has declined newborn screening, NSO sends a letter to the family (Appendix 7). A copy of this letter is cc’d to the submitting institution/midwifery practice and the infant’s primary HCP (if known).

Please see the attached documents:

1. Potential Missed Newborn Screen Alert (Appendix 7)
2. Parent letter to send IF parents have not been contacted directly OR if HCP has been informed but no repeat has been received (Appendix 7)
(Page intentionally left blank for printing purposes.)
8.1 Newborn screening education for health care providers

Education about newborn screening is vital to the success of the program. It is recommended that institutions provide orientation about newborn screening to all new employees, including review of this manual.

In addition, the staff at NSO will work with you to meet the educational needs of your institution and address specific screening practice questions.

8.2 Regional newborn screening workshops

NSO is pleased to offer workshops about newborn screening. We offer a variety of presentations on blood spot sample collection, roles and responsibilities in the newborn screening process, CCHD and pulse oximetry testing, parent education, etc. These workshops are available at NO CHARGE to your institution. However, please note that a minimum attendance of 15 persons is required to book a workshop.

If you are interested in booking a workshop please contact NSO at newbornscreening@cheo.on.ca.

8.3 Telehealth series

NSO has hosted several telehealth presentations. The telehealth presentations cover a variety of topics relevant to the newborn screening process and include a question and answer period with viewers.

Announcements regarding upcoming telehealth presentations are circulated as part of a submitter bulletin. Please e-mail newbornscreening@cheo.on.ca to subscribe to the submitter bulletin distribution list.

8.4 Newborn screening education for parents

Parent education is essential to successful newborn screening. Informed parents are better able to understand screen positive results and the next steps in the process. In addition, informed parents may experience less anxiety associated with a repeat test request for an unsatisfactory sample.

NSO has developed several resources for:

1. Health care professionals and prenatal educators to assist them in educating parents about newborn screening.

2. Parents, please see our website for a detailed listing of available resources.
8.5 Educational materials available

The following educational materials are available free of charge.

Newborn Screening Ontario (NSO) has video and print resources to help parents learn about the importance of newborn screening.

**Newborn screening in Ontario: A small test with big benefits**

This video about the importance of newborn screening is on the NSO YouTube channel. It is also available on DVD from Service Ontario at no charge (publication # 018603).

**Newborn screening and your baby: A healthy start leads to a healthier life**

This informational pamphlet is available for download on the NSO website. Print copies in English and French can be ordered from Service Ontario at no charge. Pamphlets can be ordered in English (publication # 018583) or French (publication # 018584). A holder for the pamphlets is also available for order (publication # 018604).

**Poster - Newborn Screening and Your Baby: Give Your Baby the Best Start in Life**

This informational poster about newborn screening is available in English (publication # 018583) or French (publication # 019141) from Service Ontario.

**Information Sheets**

Information sheets about screen positive results, transfused infants and preterm infants are available in English and French on the NSO website.

**Critical Congenital Heart Disease (CCHD) Screening Education**

CCHD educational material including training presentations, evaluation sheets, pulse oximetry quizzes, competency checklists and additional resources are on the NSO website.

**Forms**

Requests for newborn screening results, additional testing on the blood spot sample, destruction or release of the blood sample, sickle cell carrier results, postmortem testing, diagnostic/monitoring requisitions, and decline/defer forms can be found on the NSO website.
9.1 Introduction

Newborn Screening Ontario is committed to maintaining the privacy and confidentiality of the health information and dried blood spot samples it receives. Some parents/guardians may have concerns about the use of their children’s health information or secondary uses of the dried blood spot samples. This section outlines NSO’s policies and procedures regarding the use of infant’s health information and the dried blood spot samples.

9.2 Privacy and confidentiality of health information

NSO follows CHEO’s internal privacy policies and procedures. Accordingly, health information provided to NSO (including screening results) may be used for the following purposes:

- To provide care. Personal health information is used by care providers and trainees who are part of a child’s health care team.
- To teach. A child’s information may be used to support our partnership with the University of Ottawa and other schools, while adequately protecting their privacy.
- To conduct research and compile statistics. Researchers may use health information while working on a study approved by the CHEO Research Ethics Board.
- To improve the care we provide by conducting quality improvement and risk management activities.
- To obtain payment for treatment.

NSO may also use or disclose personal health information for the following purposes, unless parents request us not to:

- Sharing of information, in whole or in part, with health care providers outside CHEO who are involved in the care of a child.
- Conduct patient satisfaction surveys: We care about our patients and want to hear from parents about the quality of care and service they received. We use this information to help improve the care we will provide in the future.

9.3 Storage of the blood samples

Dried blood spot samples are stored in a secure facility for 19 years, as they are a part of a child’s medical record. After 19 years, the samples are destroyed. The samples for infants born before April 2006 are stored by the Public Health Laboratory in Toronto, Ontario.

Samples are stored to ensure quality screening for all infants born in Ontario. NSO regularly checks the screening cutoffs and the stored samples assist NSO in performing this task. If an infant with a negative newborn screen is diagnosed with one of the diseases screened, the infant’s stored sample can be re-tested. This helps NSO assess why the infant was missed in the newborn period, and potentially stops the same thing from happening again in the future.

9.4 Use of the blood samples

Occasionally, the dried blood spot samples may be used for other purposes after testing is finished. These include:

- Quality control and quality assurance within the NBS laboratory;
- Retesting the sample to help make a diagnosis at the request of the infant’s health care provider(s);
- After a legal warrant or court order (e.g. by the Coroner’s office if the infant has died unexpectedly);
- Release of part of the sample to another laboratory for other testing at the parent or guardian’s written request;
- Samples may be used for research approved by a research ethics board if all identifying information has been removed so it is impossible to link an individual with the research results. This is in compliance with the provisions in the Ontario Personal Health Information Privacy Act (PHIPA) 2004. Identifiable samples can only be used for research with the written consent of the individual or their surrogate decision maker (parent or guardian).
9.5 Additional uses of the blood samples

Samples may be used for other purposes in the future, but only as authorized by PHIPA or any other applicable law, and following review by Ministry of Health and Long Term Care with the advice of the NSO Advisory Council. NSO will communicate any changes in sample storage and use via their website, and, as always, will continue to protect the privacy of all infants screened.

9.6 Use of the blood sample for research

There are currently only two ways that an infant's sample could be used for research:

1. Research that needs an infant's sample linked with his/her identity. This could only happen after obtaining written consent from the child (if they were old enough to give consent) or from their surrogate decision maker (a parent or guardian). The study would have to be approved by a research ethics board.
   - The child or parent/guardian would be fully informed of the purpose of the research as well as the pros and cons of participating in the research and would have the ability to choose to participate or decline to participate in such a research study.

2. Research that requires an infant's sample may be allowed without obtaining the child's (or their surrogate decision maker's) consent ONLY IF:
   - The infant's sample is de-identified AND the study has been approved by a research ethics board.

9.7 Destruction or release of the blood sample

If parents/guardians request destruction or release of sample from NSO, the parents/legal guardian/child must complete a request form or must attend NSO offices with originals of the required identifying documents to complete the forms in person. An original copy of the form is required to complete the request.

A task force of the Ontario Advisory Committee on Newborn and Childhood Screening was created in 2008 to consider issues related to blood spot storage and use. A minimum storage length of 5 years was recommended to provide effective screening testing and quality assurance for the program. This length of time was recommended for a number of reasons, most importantly because the diseases targeted by the screening program would be expected to cause health problems for an affected child by the time they were 5 years of age. Therefore storing samples for this length of time would allow investigation and possible re-testing if a child was diagnosed with one of the conditions on our panel following a negative newborn screen. It would also allow confirmation of whether or not a screening sample was obtained on the child. For this reason, the task force also recommended that an individual (or their parents or guardians) be able to request return or destruction of the sample after this five year period. Parents/guardians who have further questions or concerns about the potential use of their child's stored sample are encouraged to contact NSO directly.
10.1 Primary disease targets by category

Ontario infants are screened for the following target diseases:

### Organic Acid Disorders
- Isovaleric acidemia
- Glutaric acidemia, type I
- Methylmalonic acidemia (mutase deficiency)

### Fatty Acid Oxidation Disorders
- Trifunctional protein deficiency
- Medium-chain acyl-CoA dehydrogenase deficiency
- Very long-chain acyl-CoA dehydrogenase deficiency

### Amino Acid and Urea Cycle Disorders
- Phenylketonuria
- Maple syrup urine disease
- Homocystinuria (CBS deficiency)

### Other Metabolic Diseases
- Galactosemia

### Endocrine Disorders
- Congenital hypothyroidism

### Other Genetic Diseases
- Cystic Fibrosis

### Hemoglobinopathies
- Sickle cell disease (HbSS, S/C, and S/β-thal)

### Immune Deficiencies
- Severe Combined Immune Deficiency

### Critical Congenital Heart Disease
- Critical Congenital Heart Disease
# 10.2 Diseases screened by symptoms

<table>
<thead>
<tr>
<th>Chronic Neurological Disease</th>
<th>Life-Threatening Episodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenylketonuria</td>
<td>Medium-chain acyl-CoA dehydrogenase deficiency</td>
</tr>
<tr>
<td>Glutaric acidemia, type I</td>
<td>Very long-chain acyl-CoA dehydrogenase deficiency</td>
</tr>
<tr>
<td>Biotinidase deficiency</td>
<td>Isovaleric acidemia</td>
</tr>
<tr>
<td>Congenital hypothyroidism</td>
<td>Maple syrup urine disease</td>
</tr>
<tr>
<td>Multi-organ Disease</td>
<td>Argininosuccinic aciduria</td>
</tr>
<tr>
<td>Sickle cell disease (HbSS, S/C, and S/β-thal)</td>
<td>Citrullinemia</td>
</tr>
<tr>
<td>Homocystinuria (CBS deficiency)</td>
<td>Methylmalonic acidemias</td>
</tr>
<tr>
<td>Long-chain 3-hydroxy-acyl-CoA dehydrogenase deficiency</td>
<td>Propionic acidemia</td>
</tr>
<tr>
<td>Trifunctional protein deficiency</td>
<td>Cobalamin A &amp; B Defects</td>
</tr>
<tr>
<td>Carnitine uptake defect</td>
<td>Congenital adrenal hyperplasia</td>
</tr>
<tr>
<td>Cystic Fibrosis</td>
<td>Severe Combined Immune Deficiency</td>
</tr>
<tr>
<td>Liver Disease</td>
<td>Critical Congenital Heart Disease</td>
</tr>
<tr>
<td>Tyrosinemia, type I</td>
<td></td>
</tr>
<tr>
<td>Galactosemia</td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**

- Organic acid disorders
- Fatty acid oxidation disorders
- Amino acid and urea cycle disorders
- Other metabolic disorders
- Endocrine disorders
- Other genetic diseases
- Hemoglobinopathies
- Immune Deficiencies
- Critical Congenital Heart Disease
## 10.3 Summary of diseases screened

<table>
<thead>
<tr>
<th>Disease</th>
<th>Incidence in Ontario</th>
<th>Primary Analyte Measured</th>
<th>Screening Can Prevent…</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argininosuccinic Acidemia (ASA)</td>
<td>1/70 000</td>
<td>ASA/citrulline</td>
<td>…developmental delay, seizures, coma, death</td>
<td>Avoid fasting, low protein diet, medication</td>
</tr>
<tr>
<td>Biotinidase Deficiency</td>
<td>1/60 000</td>
<td>Biotinidase</td>
<td>…developmental delay, hypotonia, seizures, skin rash, hair loss, death</td>
<td>Biotin (vitamin) supplementation</td>
</tr>
<tr>
<td>Carnitine Uptake Disorder (CUD)</td>
<td>Unknown as so rare</td>
<td>C0</td>
<td>…cardiomyopathy, hypotonia, hepatomegaly, encephalopathy, coma, death</td>
<td>Carnitine supplementation, avoid fasting</td>
</tr>
<tr>
<td>Citrullinemia</td>
<td>1/60 000</td>
<td>Citrulline</td>
<td>…developmental delay, seizures, coma, death</td>
<td>Low protein diet, avoid fasting, medication</td>
</tr>
<tr>
<td>Congenital Adrenal Hyperplasia (CAH)</td>
<td>1/15 000</td>
<td>17-OH-Progesterone</td>
<td>…salt-wasting crises, death</td>
<td>Hormone and mineral replacement</td>
</tr>
<tr>
<td>Congenital Hypothyroidism</td>
<td>1/3 000</td>
<td>Thyroid hormones</td>
<td>…severe and irreversible developmental delay, failure to thrive</td>
<td>Hormone replacement</td>
</tr>
<tr>
<td>Critical Congenital Heart Disease</td>
<td>3/1000</td>
<td>Oxygen saturation</td>
<td>…death</td>
<td>May include cardiac catheterization or surgery</td>
</tr>
<tr>
<td>Cystic Fibrosis (CF)</td>
<td>1/3 600</td>
<td>Immunotrypsinogen (IRT), CFTR molecular analysis</td>
<td>…severe growth failure, severe chronic lung disease, early death</td>
<td>Pulmonary therapy, enzyme replacement</td>
</tr>
<tr>
<td>Galactosemia</td>
<td>1/60 000</td>
<td>Galactose-1-phosphate uridyl transferase (GALT)</td>
<td>…failure to thrive, liver damage, sepsis, death</td>
<td>Galactose restricted diet</td>
</tr>
<tr>
<td>Glutaric Acidemia Type I (GAI)</td>
<td>Unknown as so rare</td>
<td>C5DC</td>
<td>…developmental delay, spasticity, encephalopathy, coma, death</td>
<td>Avoid fasting, low protein diet, +/- medication</td>
</tr>
<tr>
<td>Hemoglobinopathies</td>
<td>1/400 in some populations</td>
<td>Hemoglobin patterns</td>
<td>…infection and sepsis, growth delay, painful sickle crises, tissue ischemia and organ damage</td>
<td>Prophylactic antibiotics, pain management, blood transfusions, bone marrow transplant</td>
</tr>
</tbody>
</table>
### 10.3 Summary of diseases screened (continued)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Incidence in Ontario</th>
<th>Primary Analyte Measured</th>
<th>Screening Can Prevent…</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homocystinuria</td>
<td>1/200 000 to 1/300 000</td>
<td>Methionine</td>
<td>…developmental delay, lens dislocation, thromboses</td>
<td>Low methionine diet, medication, +/- dietary supplementation</td>
</tr>
<tr>
<td>Isovaleric Acidemia (IVA)</td>
<td>1/100 000 to 1/200 000</td>
<td>C5</td>
<td>…encephalopathy, neurologic damage, coma, death</td>
<td>Avoid fasting, low protein diet, medication</td>
</tr>
<tr>
<td>LCHAD Deficiency</td>
<td>Unknown as so rare</td>
<td>C16OH</td>
<td>…cardiomyopathy, seizures, developmental delay, hepatic disease, coma, death</td>
<td>Avoid fasting, diet low in long-chain fats</td>
</tr>
<tr>
<td>Maple Syrup Urine Disease (MSUD)</td>
<td>1/200 000</td>
<td>Leucine/ Isoleucine</td>
<td>…failure to thrive, seizures, developmental delay, coma, death</td>
<td>Low protein diet, avoid fasting</td>
</tr>
<tr>
<td>MCAD Deficiency</td>
<td>1/10 000</td>
<td>C8</td>
<td>…seizures, coma, sudden death</td>
<td>Avoid fasting, aggressive treatment of illness</td>
</tr>
<tr>
<td>Methylmalonic Acidemia (mutase deficiency and cobalamin A &amp; B deficiency)</td>
<td>1/50 000</td>
<td>C3</td>
<td>…failure to thrive, encephalopathy, coma, death</td>
<td>Low protein diet, avoid fasting, +/-vitamin B12 supplementation</td>
</tr>
<tr>
<td>Phenylketonuria</td>
<td>1/12 000</td>
<td>Phenylalanine</td>
<td>…severe and irreversible developmental delay</td>
<td>Phenylalanine restricted diet, supplementation</td>
</tr>
<tr>
<td>Proprionic Acidemia</td>
<td>1/100 000</td>
<td>C3</td>
<td>…encephalopathy, developmental delay, coma, death</td>
<td>Avoid fasting, low protein diet, medication</td>
</tr>
<tr>
<td>Trifunctional Protein Deficiency</td>
<td>Unknown as so rare</td>
<td>C16OH</td>
<td>…developmental delay, failure to thrive, cardiomyopathy, coma, sudden death</td>
<td>Avoid fasting, diet low in long-chain fats</td>
</tr>
<tr>
<td>Tyrosinemia Type I</td>
<td>1/100 000</td>
<td>Tyrosine and Succinylacetone</td>
<td>…liver and kidney damage and sequelae, failure to thrive, coagulopathy</td>
<td>Special diet, medication</td>
</tr>
</tbody>
</table>
10.3 Summary of diseases screened (continued)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Incidence in Ontario</th>
<th>Primary Analyte Measured</th>
<th>Screening Can Prevent...</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLCAD Deficiency</td>
<td>Unknown as so rare</td>
<td>C14:1</td>
<td>... developmental delay, failure to thrive, hepatomegaly, cardiomyopathy, coma, sudden death</td>
<td>Avoid fasting, special diet</td>
</tr>
<tr>
<td>Severe Combined Immune Deficiency</td>
<td>1/100 000 Likely an underestimate</td>
<td>T-cell receptor excision circles (TRECs)</td>
<td>...severe and life-threatening infections</td>
<td>Medications, bone marrow transplant, enzyme replacement therapy, gene therapy</td>
</tr>
</tbody>
</table>

Legend:
- Organic acid disorders
- Fatty acid oxidation disorders
- Amino acid and urea cycle disorders
- Other metabolic disorders
- Endocrine disorders
- Other genetic diseases
- Hemoglobinopathies
- Immune Deficiencies
- Critical Congenital Heart Disease

10.4 Additional newborn screening resources

Related websites

- Ministry of Health and Long Term Care  
  www.health.gov.on.ca
- National Newborn Screening & Genetics Resource Center (USA)  
  www.genes-r-us.uthscsa.edu
Regional Treatment Centres

London/Southwestern Ontario:

- London Health Sciences Centre (LHSC) - Children’s Hospital of Western Ontario
  - Medical Genetics Program of Southwestern Ontario
    (Metabolic disease, Cystic Fibrosis and SCID referrals)
  - Pediatric Endocrinology
    (Endocrine disease referrals)
  - Pediatric Hematology
    (Hemoglobinopathy referrals)

Hamilton/Central South and Central West:

- Hamilton Health Sciences Centre/ McMaster University Medical Centre
  Newborn Screening Centre
  (all newborn screening referrals)

Toronto/GTA:

- The Hospital for Sick Children
  Newborn Screening Centre
  (all newborn screening referrals)

Kingston:

- Kingston General Hospital
  Newborn Screening Centre
  (all newborn screening referrals)

Ottawa/Eastern Ontario:

- Children's Hospital of Eastern Ontario
  Newborn Screening Centre
  (all newborn screening referrals)

North-Western Ontario:

- Winnipeg Health Sciences Centre
  - Program of Genetics and Metabolism
    (Metabolic disease referrals)
  - Section of Pediatric Endocrinology
    (Endocrine disease referrals)
  - Pediatric CF Clinic
    (Cystic Fibrosis Referrals)

Northern Ontario:

- No treatment centre, most positive screening results are referred to CHEO and follow-up is coordinated with family physician/pediatrician.
- Occasionally infants from Northern Ontario are referred to other treatment centres.
11.1 NSO screening process

Overview

HCPs play a vital role in the success of NSO. The time spent educating parents, taking newborn screening samples, ensuring requisitions are filled in properly, and promptly mailing out newborn screening samples allows us to provide the best start in life to every infant born in Ontario.

Laboratory & data entry workflow

Every sample NSO receives is considered urgent. Analysis and reporting is always done on a STAT basis.

Specimen receiving and handling:

Samples are delivered to NSO Monday – Saturday by courier. Samples should be received no later than 10:00 am.

All specimens received are assessed for blood quality/quantity and barcoded for subsequent entry into the NSO Database. At the barcoding stage, each requisition/blood sample is reviewed for sample quality and quantity. Those samples that are of satisfactory quality/quantity are then barcoded in duplicate. Any samples that are possibly “unsatisfactory” during sample review are set aside for evaluation by the laboratory head or resource/senior technologist. For information on unsatisfactory samples, please see Section 5.

Blood cards suitable for analysis are bundled into groups of 50 and passed on to the technicians in charge of punching on the multi-puncher.

Procedure in the NSO lab for blood spot punching:

A “punch” is an excised circle of blood which is subsequently used for sample analysis. Each and every sample received is tracked at all times. All samples are punched into barcoded Microplates that are designated for a specific method/procedure. The minimum number of punches required for a collection to be of sufficient quantity is currently 10. This may increase as the newborn screening panel expands. NSO uses 3.2 mm punches, which are taken from the blood spot collection card.

Re-punched samples:

Specimens may be deemed unsuitable for reporting for several reasons:

- Machine malfunction
- QC issues
- Instrumental flags
- Equivocal results of unknown reason upon review by laboratory head or designate.

In these situations, the sample will typically be re-punched singly and processed for the specific method in question:

- Specimens flagged as an initial positive are re-punched in duplicate for confirmation and are processed overnight and reported out the following day.

Exceptions where an abnormal result will be re-evaluated for confirmation on the same day of initial analysis include very provocative results for disorders where the delay in diagnosis may have catastrophic consequences such as:

- Citrullinemia
- MSUD

Data entry

Data entry clerks are responsible for entering demographic information into the NSO database on every infant whose sample we receive. In order to ensure accuracy, key fields are entered in duplicate by two different clerks. This information includes the infant and parent’s name, the infant’s OHIP number, the ordering physician/midwife, the submitting hospital/doctor/midwifery practice and contact information for the infant’s mother. In the event that an infant screens positive, this information allows the treatment centre to contact the family immediately to arrange further testing. If any critical information is missing, a data entry clerk contacts the submitter to obtain the missing information. The NSO data entry team aims to enter all information on the same day that a specimen is received - this can be up to 1300 specimens daily!

Screen positive reporting

Infants identified to be at increased risk for a disease on the NSO panel are screen positive. All screen positive infants are referred to a regional treatment centre for follow-up and diagnostic investigations.
References

Appendix 2  Parent information sheet

(front)

FEUILLET D’INFORMATION POUR LES PARENTS

Des tests ont été effectués sur votre bébé afin de déjacter des maladies graves pouvant causer un retard intellectuel, un retard de croissance ou le décès si elles ne sont pas traitées. Dépistage néonatal Ontario (DNO) signalera les résultats du dépistage sanguin à l’hôpital ou au fournisseur de soins de santé qui a envoyé l’échantillon.

Un résultat positif signifie que votre bébé court un plus grand risque d’avoir une maladie déjactée et votre bébé sera référé à des spécialistes dans un centre de traitement pour des tests de suivi.

Un résultat négatif signifie que votre bébé court un risque très faible d’avoir une des maladies déjactées et qu’aucun suivi n’est nécessaire. Si l’échantillon de votre bébé est prélevé avant l’âge de 24 heures, demandez à votre sage-femme, infirmier(e) praticien(ne), ou au médecin du bébé de répéter le test de dépistage néonatal dans les 5 jours suivants. Si un nouvel échantillon est nécessaire pour d’autres raisons, DNO contactera le professionnel ou l’établissement de santé qui a envoyé l’échantillon.

Si vous avez des questions ou souhaitez recevoir de plus amples informations, veuillez en parler au médecin, infirmier(e) praticien(ne) ou sage-femme et demandez la brochure sur le dépistage néonatal en Ontario. Vous pouvez aussi visiter notre site web www.newbornscreening.on.ca ou contacter Dépistage néonatal Ontario.

Inserctions for Hospital:

Remove this top sheet and give to parent.

Completely fill out the first copy of the requisition form.

USE BALL POINT PEN. PRESS HARD. INSTRUCTIONS ON BACK, PRINT LEGIBLY. IF A STAMP IS USED, STAMP ALL COPIES. COMPLETE ALL FIELDS.
Appendix 2b

Decline/defer form from blood card

NEWBORN SCREENING ONTARIO DECLINE/DEFER FORM FOR CRITICAL CONGENITAL HEART DISEASE (CCHD) SCREENING

Please have the form completed and returned to NSO if the parent/guardian declines or defers CCHD newborn screening.

I have been informed that / J’ai été informé que :

1. Newborn screening for CCHD is a medical recommendation and is considered standard of care for every baby born in Ontario. My baby can look normal and still have CCHD, which can cause severe health problems and/or sudden infant death. The goal of CCHD screening is early detection - so that treatment can be started early and better health achieved. The dépistage néonatal de la CCC est une recommandation médicale et est considéré comme un standard de soins pour tous les bébés nés en Ontario. Mon bébé peut paraître normal et avoir des problèmes de santé sévères et/ou un décès soudain. L’objectif du dépistage de la CCC est la détection précoce - afin de permettre un traitement plus rapide et un meilleur résultat.

2. It is best to do newborn screening for CCHD between 24-48 hours of age. If my baby leaves hospital before 24 hours of age, my health care provider should make arrangements to have the CCHD screen done when my baby is 24-48 hours of age. Idéalement, le dépistage néonatal de la CCC se fait entre 24 et 48 heures après la naissance. Si mon bébé quitte l’hôpital moins de 24 heures après sa naissance, mon fournisseur de soins de santé devrait prendre les dispositions nécessaires pour que le dépistage de la CCC soit effectué lorsque mon bébé aura 24 à 48 heures.

3. My baby’s CCHD screening results and screen positive follow-up information are collected by NSO to ensure he or she has been effectively screened. NSO will also use this information to maintain and improve the quality of the CCHD newborn screening program. NSO is committed to keeping my baby’s information safe and confidential. NSO meets or exceeds all the requirements set out in Ontario’s Personal Health Information Protection Act, 2004, for the protection of personal health information. Les résultats du dépistage de la CCC de mon bébé et l’information du suivi associé à un dépistage positif sont recueillis par NSO pour s’assurer que mon bébé a été effectivement dépisté. NSO utilisera également cette information pour maintenir et améliorer la qualité du programme de dépistage néonatal de la CCC. NSO respecte ou dépasse toutes les exigences en matière de protection des renseignements personnels édictées dans la Loi sur la protection des renseignements personnels sur la santé de l’Ontario de 2004.

4. This form will be sent to NSO to document that CCHD screening was offered to me, and if I have declined to make sure I am not contacted about this. Ce formulaire sera envoyé au DNO pour confirmer que le dépistage de la CCC m’a été offert et, si j’ai refusé ce dépistage, que je ne serai pas contacté à ce sujet.

Please complete the relevant section / Veuillez remplir la section pertinente.

- I choose NOT to have my baby’s CCHD screening done. Je choisis de refuser le dépistage de la CCC de mon bébé.
- My baby will be discharged before 24 hours of age and I plan to have my baby screened for CCHD, optimally by 48 hours of age. Mon bébé sera déchargé avant 24 heures après sa naissance et je prévois que mon bébé fera le dépistage de la CCC, idéalement dans les 48 heures suivantes.

Baby’s name/Nom du bébé

(Please also complete the Demographic section of the CCHD card and the NBS card, including date of birth and health card number. Veuillez aussi remplir la section « Démographie » de la carte NBS, y compris la date de naissance du bébé et le numéro de la carte santé.)

Parent/guardian: signature Signataire du parent ou tuteur

Date

Physician/midwife: signature Signataire du médecin ou de la sage-femme

Date

Appendix 2c

CCHD Results

NEWBORN SCREENING ONTARIO CRITICAL CONGENITAL HEART DISEASE (CCHD) SCREENING RESULTS SHEET

Please evaluate screening result with NSO CCHD screening algorithm or evaluation chart.

INFANT

Last Name

First Name

Multiple Birth:

Sex: M

F

Ambiguous

Health Card Number

Submitter Unique Number

Date of CCHD screen

PM

AM

Time of screen

PM

AM

Difference: %

PM

AM

Repeat

Pass

Refer *

Reason screen not done

(checkbox that applies)

- Decline/deferred (complete form on back of page)
- Infant in or is expected to be in NICU/SCN/PICU over 7 days
- Infant diagnosed prenatally with heart defect
- Infant diagnosed with heart defect by physical exam
- Other (ex. limb anomaly). Specify ____________________________

__________________________________________________________________________

FACULTATIVE: Raisons pour lesquelles j’ai choisi que mon bébé fasse NE PAS LE DÉPISTAGE DE LA CCC

OPTIONAL: The reason(s) I have chosen not to have my baby screened is ____________________________

______________________________________________________________________________________

© 2018 Copyright: Ontario Ministry of Health and Long-Term Care, Newborn Screening Program.
Appendix 3  Sample screen negative report

<table>
<thead>
<tr>
<th>Test</th>
<th>Screening Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino Acidemias:</td>
<td></td>
</tr>
<tr>
<td>Phenylketonuria and Variants / Biotin Defects</td>
<td>Negative</td>
</tr>
<tr>
<td>Maple Syrup Urine Disease</td>
<td>Negative</td>
</tr>
<tr>
<td>Homocystinuria / Hypermethioninamias</td>
<td>Negative</td>
</tr>
<tr>
<td>Citrullinemia / Argininosuccinic Aciduria</td>
<td>Negative</td>
</tr>
<tr>
<td>Tyrosinemia</td>
<td>Negative</td>
</tr>
<tr>
<td>Amino Acidopathies, other</td>
<td>Negative</td>
</tr>
<tr>
<td>Organic Acidemias:</td>
<td></td>
</tr>
<tr>
<td>Propionic / Methylmalonic Acidemia</td>
<td>Negative</td>
</tr>
<tr>
<td>Isovaleric Acidemia / 2 Methylbutyric Acidemia</td>
<td>Negative</td>
</tr>
<tr>
<td>Glutaric Acidemia Type I</td>
<td>Negative</td>
</tr>
<tr>
<td>3 Methylcrotonic / Hydroxymethylglutaric / Methylglutaconic / 2-Methyl, 3-Hydroxybutyric Acidemia, or 3-Ketothiolase Deficiency</td>
<td>No Longer Tested</td>
</tr>
<tr>
<td>Fatty Acid Oxidation Defects:</td>
<td></td>
</tr>
<tr>
<td>Medium Chain Acyl Dehydrogenase Deficiency / Glutaric Acidemia Type 2</td>
<td>Negative</td>
</tr>
<tr>
<td>Very Long Chain Acyl Dehydrogenase Deficiency</td>
<td>Negative</td>
</tr>
<tr>
<td>Long Chain Hydroxy/ Acatyl Dehydrogenase / Trifunctional Protein Deficiencies</td>
<td>Negative</td>
</tr>
<tr>
<td>Carnitine Uptake Defect</td>
<td>Negative</td>
</tr>
<tr>
<td>Fatty Acid Oxidation Disorders, other</td>
<td>Negative</td>
</tr>
<tr>
<td>Galactosemia</td>
<td>Negative</td>
</tr>
<tr>
<td>Biotinidase Deficiency</td>
<td>Negative</td>
</tr>
<tr>
<td>Endocrine Disorders:</td>
<td></td>
</tr>
<tr>
<td>Congenital Hypothyroidism</td>
<td>Negative</td>
</tr>
<tr>
<td>Congenital Adrenal Hyperplasia</td>
<td>Negative</td>
</tr>
<tr>
<td>Sickle Cell and other Hemoglobinopathies:</td>
<td></td>
</tr>
<tr>
<td>Cystic Fibrosis</td>
<td>Negative</td>
</tr>
<tr>
<td>Severe Combined Immune Deficiency:</td>
<td>Negative</td>
</tr>
</tbody>
</table>

1. This HCP was indicated on the requisition form as one who will be involved in the infant’s care following discharge and is not necessarily the HCP who ordered the newborn screening test.  
2. Screening negative means that this infant is at decreased risk for the disease(s). Screening positive means that this infant is at increased risk for the disease(s). It does not mean that a disease is present, but further testing is indicated. If a test is positive and you and/or your patient have not already been contacted, please call NSO at (613) 738-3222.  
3. This report does NOT contain information about this infant’s carrier status for the hemoglobinopathies. Families wishing to learn their child’s carrier result should contact NSO or visit www.newbornscreening.on.ca.  
4. Infants with meconium ileus are at high risk of having Cystic Fibrosis (CF) but will often have a screen negative result for CF. It is therefore recommended that they be clinically evaluated for CF regardless of the newborn screening results.
## Appendix 4  Sample screen positive report and referral paperwork

<table>
<thead>
<tr>
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<td>Negative</td>
</tr>
<tr>
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</tr>
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<td></td>
</tr>
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<td>Negative</td>
</tr>
<tr>
<td>Endocrine Disorders:</td>
<td></td>
</tr>
<tr>
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<td>Positive</td>
</tr>
<tr>
<td>Congenital Adrenal Hyperplasia</td>
<td>Negative</td>
</tr>
<tr>
<td>Sickle Cell and other Hemoglobinopathies:</td>
<td></td>
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3. The result does not contain information about this infant’s carrier status for the hemoglobinopathies. Families wishing to learn their child’s carrier result should contact NSO or visit www.newbornscreening.on.ca.

4. Infants with monoclonal bands are at high risk of having Cystic Fibrosis (CF) but will often have a screen negative result for CF; it is therefore recommended that they be clinically evaluated for CF regardless of the newborn screening results.

---

**Submitter:** Doe, Aaron

**Gender:** Male

**Date Received:** 2014/10/07

**Date Reported:** 2014/10/09

**Infant’s Health Care Provider:** Smith, Aaron

<table>
<thead>
<tr>
<th>Test</th>
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</tr>
</thead>
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<tr>
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<td>Negative</td>
</tr>
<tr>
<td>3-methylcrotonic / hydroxymethylglutaric / methylglutaconic / 2-methyl 3-hydroxybutyric acidemia, or 1-ketohidrolase deficiency</td>
<td>No longer tested</td>
</tr>
<tr>
<td>Fatty acid oxidation defects</td>
<td></td>
</tr>
<tr>
<td>Medium chain acyl dehydrogenase deficiency / glutaric acidemia type 2</td>
<td>Negative</td>
</tr>
<tr>
<td>Very long chain acyl dehydrogenase deficiency</td>
<td>Negative</td>
</tr>
<tr>
<td>Long chain hydroxyl acyl dehydrogenase / trifunctional protein deficiencies</td>
<td>Negative</td>
</tr>
<tr>
<td>Carnitine uptake defect</td>
<td>Negative</td>
</tr>
<tr>
<td>Fatty acid oxidation disorders, other</td>
<td>Negative</td>
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<tr>
<td>Galactosemia</td>
<td></td>
</tr>
<tr>
<td>Biotinidase deficiency</td>
<td>Negative</td>
</tr>
<tr>
<td>Endocrine disorders</td>
<td></td>
</tr>
<tr>
<td>Congenital hypothyroidism</td>
<td>Positive</td>
</tr>
<tr>
<td>Congenital adrenal hyperplasia</td>
<td>Negative</td>
</tr>
<tr>
<td>Sickle cell and other hemoglobinopathies</td>
<td></td>
</tr>
<tr>
<td>Cystic fibrosis</td>
<td>Negative</td>
</tr>
<tr>
<td>Severe combined immune deficiency</td>
<td>Negative</td>
</tr>
</tbody>
</table>
Appendix 4  Sample screen positive report and referral paperwork

**NEWBORN SCREENING ONTARIO**  
**Dépistage Neonatal ONTARIO**

**DOE, Baby Girl**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Card Number</td>
<td>0123456789</td>
</tr>
<tr>
<td>NSO Accession Number</td>
<td>201801010001</td>
</tr>
<tr>
<td>Mother's Name</td>
<td>DOE, Jane</td>
</tr>
<tr>
<td>Phone #:</td>
<td>123-456-7890</td>
</tr>
<tr>
<td>Address</td>
<td>123 Any St, Anytown, ON H0H 0H0</td>
</tr>
<tr>
<td>Submitter Unique Number</td>
<td>ABC012345</td>
</tr>
<tr>
<td>Submitting Facility</td>
<td>Hospital Name</td>
</tr>
<tr>
<td>Date Received</td>
<td>2018-01-01</td>
</tr>
</tbody>
</table>

**Date Received**: 2018-01-01  
**Date of Report**: 2018-01-09  
**D.O.B.**: 2017-12-29 00:01  
**D.O.C.**: 2017-12-30 01:05  
**Gender**: Female  
**Feed Type**: breast  
**Gestational Age**: 38.2  
**Birth Weight**: 3300g

**Analyte** | **Result [mIU/L]** | **Cutoff** | **Reference Interval**  
---|---------------------|------------|-------------------------|
  TSH       | 102.3              | 17.0       | Age <7 days              | Age >7 days  
            |                    |            | <9.6                    | <5.5          

**COMMENTS:**

Screen positive for Congenital Hypothyroidism.

Lawrence Fisher  
Resource Technologist for

Nathalie Lepage, PhD, FCCMG, FCACB  
Laboratory Head of Inherited Metabolic Diseases

Matthew P.A. Henderson, PhD, FCACB  
Laboratory Head of Biochemistry

Dr. P. Chakraborty, MD, FRCP, FCCMG  
Executive Director

Version July, 2017
Appendix 4  Sample screen positive report and referral paperwork

Dear Doctor,

This letter confirms the phone call that we made to your office on 2014-11-13 in order to refer you the above-named infant.

This infant was screened on 2014/01/02 and was screen positive for Congenital Hypothyroidism. Newborn Screening Ontario and its screening laboratory are responsible for the confirmation of the diagnosis of Congenital Hypothyroidism. We would therefore appreciate your assistance in the diagnostic evaluation of this infant. It is also important that you confirm retrieval of the infant and communicate to us the results of the tests used to establish the infant’s diagnosis. We would therefore be grateful if you could complete the retrieval confirmation and diagnostic evaluation report forms and submit them to NSO.

Thank you for your collaboration and please accept our kind regards.

Sincerely,

[Signatures]

Dr. Michael Geraghty, MBBS, FRCPC  Dr. Pranesh Chakraborty, MD, FRCPC
Medical Consultant  Director
OHIP Billing #: 015515  OHIP Billing #: 016047

1 This HCP was indicated on the requisition form as one who will be involved in the infant’s care following discharge and is not necessarily the HCP who ordered the newborn screening test.

Version date: March 3, 2014

415 Smyth Road, Ottawa Ontario K1H 8M8   Phone: 613-738-3222 · 1-877-NBS-8330 · Fax: 613-738-0853
www.newbornscreening.on.ca  · newbornscreening@cheo.on.ca
Appendix 4  Sample screen positive report and referral paperwork

### Diagnostic Evaluation Report Form

**DOE, BABY BOY**

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Card Number:</td>
<td>1234567890</td>
</tr>
<tr>
<td>NSO Accession Number:</td>
<td>201401010001</td>
</tr>
<tr>
<td>Infant’s HCP:</td>
<td>Dr. B. Jones</td>
</tr>
<tr>
<td>Gender:</td>
<td>Male</td>
</tr>
<tr>
<td>Submitting Facility:</td>
<td>Birth Hospital</td>
</tr>
<tr>
<td>Referring Physician:</td>
<td>Dr. Pranesh Chakraborty (Billing #: 016047)</td>
</tr>
<tr>
<td>Determination ID:</td>
<td>00000</td>
</tr>
<tr>
<td>Screen Positive for:</td>
<td>Congenital Hypothyroidism</td>
</tr>
<tr>
<td>Treatment Centre:</td>
<td>Regional Treatment Centre</td>
</tr>
</tbody>
</table>

#### RETRIEVAL AND CLINICAL STATUS:

- Infant’s name: Same as above
- Infant’s HCP: Same as above
- Date of first contact with family/MD: Same as above
- Date of retrieval for diagnostic evaluation: Same as above
- Diagnosis was established prior to the newborn screening referral? (y/n): Yes
- If yes, was the diagnosis made prenataly, postnatally, both: Prenatally

#### DIAGNOSTIC EVALUATION:

**Results of Initial Investigations** (Please complete form and/or attach reports)

<table>
<thead>
<tr>
<th>Test</th>
<th>Date Performed (YY/MM/DD)</th>
<th>Result (unit)</th>
<th>Reference Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thyroid Scan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck Ultrasound</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRAb (infant)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal Abs (specify:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Not Done**

<table>
<thead>
<tr>
<th>Test</th>
<th>Date Performed (YY/MM/DD)</th>
<th>Reference Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thyroid Scan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck Ultrasound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRAb (infant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal Abs (specify:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Clinical evaluation by specialist physician completed, and no further testing deemed necessary*
- Parents/guardian declined diagnostic evaluation please indicate reason:
  - Previous child with positive screen and normal diagnostic testing
  - Current child had a negative screen in addition to positive screen
  - Parents declined

*Please attach relevant documentation

CONTINUED ON NEXT PAGE
Appendix 4   Sample screen positive report and referral paperwork
### Appendix 5  Sample transfusion report and follow-up letters

<table>
<thead>
<tr>
<th>Test Screen</th>
<th>Screening Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino Acidemias:</td>
<td>Negative</td>
</tr>
<tr>
<td>Phenyketonuria and Variants / Bioprotein Defects</td>
<td>Negative</td>
</tr>
<tr>
<td>Maple Syrup Urine Disease</td>
<td>Negative</td>
</tr>
<tr>
<td>Homocystinuria (Hyperhomocystinemia)</td>
<td>Negative</td>
</tr>
<tr>
<td>Citrulinerias / Argininosuccinic Aciduria</td>
<td>Negative</td>
</tr>
<tr>
<td>Tyrosinerias</td>
<td>Negative</td>
</tr>
<tr>
<td>Amino Acidopathies, other</td>
<td>Negative</td>
</tr>
<tr>
<td>Organic Acidemias:</td>
<td>Negative</td>
</tr>
<tr>
<td>Propionic / Methylosuccinic Acidemias</td>
<td>Negative</td>
</tr>
<tr>
<td>Isovaleric Acidemia / 2 Methylbutyric Acidemia</td>
<td>Negative</td>
</tr>
<tr>
<td>Glutaric Acidemia Type I</td>
<td>Negative</td>
</tr>
<tr>
<td>3-Methylcrotonic / Hydroxyisocaproic / Methylglutaconic / 2-Methyl-3-Hydroxybutyric Acidemias, or 1-Ketohidazole Deficiency</td>
<td>No Longer Tested</td>
</tr>
<tr>
<td>Fatty Acid Oxidation Defects:</td>
<td>Negative</td>
</tr>
<tr>
<td>Medium Chain Acyl Dehydrogenase Deficiency / Glutaric Acidemia Type 2</td>
<td>Negative</td>
</tr>
<tr>
<td>Very Long Chain Acyl Dehydrogenase Deficiency</td>
<td>Negative</td>
</tr>
<tr>
<td>Long Chain Hydroxy Acyl Dehydrogenase / Trifunctional Protein Deficiencies</td>
<td>Negative</td>
</tr>
<tr>
<td>Carnitine Uptake Defect</td>
<td>Negative</td>
</tr>
<tr>
<td>Fatty Acid Oxidation Disorders, other</td>
<td>Negative</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Screen</th>
<th>Screening Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galactosemia:</td>
<td>Negative</td>
</tr>
<tr>
<td>Biotinidase Deficiency:</td>
<td>Negative</td>
</tr>
<tr>
<td>Endocrine Disorders:</td>
<td>Negative</td>
</tr>
<tr>
<td>Congenital Hypothyroidism</td>
<td>Negative</td>
</tr>
<tr>
<td>Congenital Adrenal Hyperplasia</td>
<td>Negative</td>
</tr>
<tr>
<td>Sickle Cell and other Hemoglobinopathies:</td>
<td>Negative</td>
</tr>
<tr>
<td>Cystic Fibrosis:</td>
<td>Negative</td>
</tr>
<tr>
<td>Severe Combined Immune Deficiency:</td>
<td>Negative</td>
</tr>
</tbody>
</table>

Transfusions are known to affect the results of the Hemoglobin and Galactosemia screens. A transfusion has been indicated for this baby. A repeat sample is recommended at 4-6 months, but may not be necessary if a pre-transfusion sample has already been received. Please contact NSO if you have questions.

1. This HCP was indicated on the requisition form as one who will be involved in the infant’s care following discharge and is not necessarily the HCP who ordered the newborn screening test.

2. Screen negative means that this infant is at decreased risk for the disease(s).

3. Screen positive means that this infant is at increased risk for the disease(s). It does not mean that a disease is present, but further testing is indicated. If a test is positive aid you and/or your patient have not already been contacted, please call NSO at (613) 738-3222.

4. Infants with meconium ileus are at high risk of having Cystic Fibrosis (CF) but will often have a screen negative result for CF; it is therefore recommended that they be clinically evaluated for CF regardless of the newborn screening results.
Appendix 5  Sample transfusion report and follow-up letters

HOSPITAL FAX: 1234567890

January 27, 2017

RE: TEST, TEST DECLINE
Health Card Number: 1234567890 Gender: Female
NSO Accession#: 20060103401 DOB: 1998-01-01 00:01
Mother’s Name: TEST CASE, MOM DOC: 1998-01-01 10:00
Submitter Unique #: Transfusion: 

A request for a repeat newborn screening sample was made in writing for the above baby because the baby had a packed red blood cell (PRBC) transfusion prior to the original screen. A repeat sample is required to complete screening for galactosemia and the hemoglobinopathies. The submitting institution/midwifery practice that took the initial newborn screening sample is responsible for ensuring the repeat sample is done 4-6 months after the baby’s most recent transfusion, even if the infant has been discharged.

Unfortunately, according to our current records, no repeat sample has been received.

Please complete and return this form to Newborn Screening Ontario (NSO) by fax 613-738-0853 as soon as possible.

The transfusion status may have been incorrectly reported on the first sample, or our system may not be able to locate a repeat sample due to changes in demographic information. Please advise us if any of the following apply:

☐ hospital records indicate this baby did not have a blood product transfusion
☐ hospital records indicate this baby was transfused but did not have a PRBC transfusion
☐ this baby is deceased
☐ this baby received additional transfusions (Dates: ______________) so sufficient time (>4 months) has not passed
☐ this baby had diagnostic testing performed for galactosemia and hemoglobinopathies, negating the need for a repeat NBS
☐ a repeat sample was drawn on Date: ______________ (must be 4-6 months after last PRBC transfusion). If this was done under a different name, please indicate. Baby’s Name: ______________
☐ a repeat sample was requisitioned on a sample taken 4-6 months following the last transfusion. NSO #: ____________________________

OR

The family was contacted and advised that the initial newborn screen was unsatisfactory, their baby may still be at risk for some conditions on the panel, and a repeat newborn screen is recommended.

☐ parent(s) indicated that they will be bringing the infant back to the hospital/midwifery practice for a sample
☐ parent(s) declined newborn screening

OR

The family was not contacted regarding the unsatisfactory result and need for a repeat newborn screen.

☐ The infant’s health care provider was informed of the recommendation for a repeat newborn screen.
   Name: ___________________________ Phone: ____________________ Fax: __________________
☐ Health care provider not available/not informed

FORM COMPLETED BY: ___________________________ (Please print – Name and job title)
Phone Number: ___________________________ Ext. ___________________________ Date: ___________________________
Appendix 5  Sample transfusion report and follow-up letters

Dear Dr. A. Smith
Fax: 456-789-0123

RE: DOE, BABY BOY
Date of Birth: 2014/01/01  Health Card Number: 1234567890
Mother’s name: Doe, Mother
Address: 123 Any Street
City, ON H0H0H0
Mother’s phone number: 123-456-7890

The above named infant was reported to have had a packed red blood cell (PRBC) transfusion prior to their initial newborn screening test. PRBC transfusions can interfere with the screening results for two conditions on the newborn screening panel – galactosemia and the hemoglobinopathies. To complete the newborn screening process for this infant, a repeat sample is recommended 4 to 6 months after their most recent transfusion.

According to our records, no repeat sample has been received for this infant. The hospital/midwife that obtained the initial newborn screening sample advised us they communicated the recommendation for a repeat sample to your office. Newborn Screening Ontario (NSO) requests your assistance to ensure this infant has received appropriate screening for all diseases on the panel.

The repeat newborn screen needs to be taken on a special filter paper that is NOT available at most community blood laboratories. For this reason, most babies will have to go back to the hospital where they were born for their repeat test. Please inform the family that a repeat newborn screen is recommended and have them contact the postpartum or mother/infant floor at the hospital where the initial sample was taken for information about how to get the newborn screening test repeated.

If you have questions about this letter please contact NSO at (613) 738 3222. Additional information can be found in the enclosed pamphlet and at www.newbornscreening.on.ca.

Sincerely,

Members of Newborn Screening Ontario

cc: Birth Hospital, Fax: 789-456-0123
Appendix 5  Sample transfusion report and follow-up letters

NEWBORN SCREENING ONTARIO
DÉPISTAGE NEONATAL ONTARIO

BIRTH HOSPITAL
FAX: 456-789-0123

RE: DOE, BABY BOY
Health Card Number: 1234567890
Submitter Accession #: ABC123
NSO#: 201401010001
Mother’s Name: Doe, Mother

Gender: Male
DOB: 2014/01/01

Newborn Screening Ontario (NSO) requested a repeat newborn screening sample in writing for the above infant to complete screening for galactosemia and the hemoglobinopathies because the infant had a packed red blood cell (PRBC) transfusion prior to their initial newborn screening test.

The submitting institution/midwifery practice that took the initial NBS sample is responsible for ensuring the repeat sample is done 4-6 months after the infant’s most recent transfusion, even if the infant has been discharged. Unfortunately, according to our current records, no repeat sample has been received. As the infant is now over a year of age, NSO assumes that due diligence to obtain a repeat sample was given on behalf of the submitting institution/midwifery practice that took the initial NBS sample, and that these efforts were unsuccessful and NSO has closed this infant’s case. If necessary, the case can be reopened with additional information.

If you have questions or concerns about this notification, or additional information about this infant you would like to share with us, please contact the genetic counsellor with Newborn Screening Ontario at 613-738-3222, option 1.

Thank you very much for your time and cooperation.

Sincerely,

Dr. P. Chakraborty, MD, FRCPC, FCCMG
Program Director

Cc: Family doctor

Version Date: Apr 17, 2014
Appendix 6  Sample unsatisfactory report and follow-up letters

Newborn Screening Ontario
Children's Hospital of Eastern Ontario
415 Smyth Road
Ottawa, Ontario K1H 8M8

TEST, SPECIMEN B

| Health Card Number: | 123456789 |
| NSO Accession Number: | 20000010001 |
| Submitter Unique Number: | XXXXXXXXXXX |
| Submitter: | test hosp |
| Mother's Name: | MOM |
| Infant's Health Care Provider: | SMITH, ERIC |

D.O.B.: 2006/06/02
Date Received: 2006/06/02
Date Reported: 23:59

The sample received from your patient was not adequate for the following reason(s):

- Quantity of blood insufficient (Filter paper not completely saturated)
- Blood spots appear scratched or abraded
- Blood spots are supersaturated
- Blood spots appear diluted
- Blood spots exhibit "serum rings"
- Specimen delivered to lab more than 14 days after collection
- Sample collected at < 24 hours
- Insufficient data provided
- Blood spots appeared to be damaged or delayed in transit
- Blood dot collection paper expired
- Other

A REPEAT SAMPLE IS REQUESTED AS SOON AS POSSIBLE.

1. This HCP was indicated on the requisition form as one who will be involved in the infant's care following discharge and is not necessarily the HCP who ordered the newborn screening test.

Education of your staff concerning sample collection / handling and the provision of necessary legible information may be indicated. Please contact NSO at (613) 738-3222 if you have any questions or would like further information or guidance.
Appendix 6  Sample unsatisfactory report and follow-up letters

NEWBORN SCREENING ONTARIO
DÉPISTAGE NEONATAL ONTARIO

RE:  TEST, TEST DECLINE

HOSPITAL
FAX: 13-456-7890

January 27, 2017

Health Card Number: 1234567890

NSO Accession#: 200601013401

Gender: Female

Mother’s Name: TEST CASE, MOM

DOB: 1998-01-01 00:01

Submitter Unique #: DOC: 1998-01-01 10:00

A request for a repeat newborn screening sample was made in writing and/or by telephone for the above infant. Unfortunately, according to our records, no repeat sample has been received.

Please complete and return this form to Newborn Screening Ontario by fax to (613) 738-0853 as soon as possible indicating which of the following applies:

☐ A REPEAT newborn screening sample was collected and shipped to NSO:
  Date of Collection: __________________ Purolator Tracking #: ____________________________
  Infant’s Name, if different than above: ______________________________________________________

☐ A negative report has been received for this infant, please indicate NSO# __________________________

OR

The family was contacted and advised that the initial newborn screen was unsatisfactory, their infant may still be at risk for all the diseases on the panel, and a repeat newborn screen is recommended.

☐ parent(s) indicated that they will be bringing the infant back to the hospital/midwifery practice for a sample

☐ parent(s) declined newborn screening

OR

The family was not contacted regarding the unsatisfactory result and need for a repeat newborn screen.

☐ The infant’s health care provider was informed of the need for a repeat newborn screen.
  Name: ___________________________ Phone: ____________________ Fax: __________________

☐ Health care provider not available/not informed

FORM COMPLETED BY: ___________________________

(Please print – Name and Job Title)

Phone Number: ___________________________ Ext. ____________ Date: ___________________________
Appendix 6  Sample unsatisfactory report and follow-up letters

Dear MOM TEST CASE

STREET NAME CITY, ON

RE: TEST, TEST DECLINE

DOB: 1998 01-01

Reference #: 200601013401

Health Card Number: 1234567890

A blood sample was taken from your baby shortly after birth for the newborn screening test. Unfortunately, this sample was not satisfactory for testing and a repeat test is needed. We notified HOSPITAL that a repeat sample from your baby was needed but we have not yet received one. We are sending you this letter to make sure you know that your baby's newborn screen is not complete and a new sample is needed, in case HOSPITAL has not been able to reach you.

What is newborn screening?
Using a heel prick test, a small amount of blood is collected from all babies shortly after birth. This blood is sent to Newborn Screening Ontario where it is tested for 29 treatable diseases. With these diseases, early diagnosis is the key to effective treatment. Early detection of these diseases through newborn screening prevents serious health problems and can save lives.

Newborn screening is not mandatory. It is considered the standard of care for every baby and is highly recommended. Newborn screening is the only way to find babies with these diseases early enough to prevent serious, long-term health problems. Additional information can be found in the enclosed pamphlet and at www.newbornscreening.on.ca.

Why does my baby need a repeat newborn screening test?
Your baby may need a repeat test if:
- Your baby's first sample was taken before 24 hours of age
- Not enough blood was taken
- The sample was of poor quality

It is important that the repeat sample is taken as soon as possible so that your baby gets the full benefit of newborn screening. Repeating a repeat sample does not mean there is anything wrong with your baby.

Who should I contact to have a repeat sample taken?
Please contact the postpartum / mother-baby floor at the hospital where your baby was born or your midwife, who is responsible for arranging the repeat test. The repeat sample needs to be taken on a special filter paper that is NOT available at most community blood laboratories. For this reason, most babies born in hospital will have to go back to the hospital where they were born for their repeat test.

If you or your baby's health care provider (doctor /nurse practitioner/midwife) has questions about this letter you can contact Newborn Screening Ontario at 1-877-627-8330.

Sincerely,
The Newborn Screening Ontario Team

cc: HOSPITAL
    Family doctor

Fax:

January 27, 2017

Version January 2017

415 Smyth Road, Ottawa Ontario K1H 8M8  Phone: 613-738-3222 · 1-877-NBS-8330 · Fax: 613-738-0853
www.newbornscreening.on.ca · newbornscreening@cheo.on.ca · @NBS_Ontario
Appendix 7  Sample potential missed newborn screen alert and follow-up letter

TEST HOSP
FAX:

POTENTIAL MISSED NEWBORN SCREEN ALERT

RE: TEST, TEST DECLINE

Health Card Number: 6968123833  Gender: Female
NSO Accession#: 200601013401  DOB: 1998-01-01
Mother’s Name: TEST CASE, MOM Submitter Unique #: 

The BORN system has notified Newborn Screening Ontario (NSO) that this infant was born over 7 days ago and no newborn screen has been received at NSO.

Newborn screening is recommended for all infants. It is the responsibility of perinatal and newborn health care providers to ensure that all infants in their care are offered newborn screening tests.

Please complete this form and fax to NSO at (613) 738-0853 as soon as possible.

A newborn screening sample was collected and shipped to NSO:

☐ Date of Collection: _____________  Infant’s Name: _____________________________
☐ Submitter: _____________________  Purolator Tracking Number: __________________________

OR

The family was offered newborn screening.

☐ parent(s) indicated that they will be bringing the infant back to the hospital/midwifery practice for a sample
☐ parent(s) declined newborn screening

OR

The family was not contacted regarding the potential missed newborn screen.

☐ The infant’s health care provider was informed of the potential missed screen.
  Name: ______________________ Phone: __________________ Fax: __________________
☐ Health care provider not available/not informed

FORM COMPLETED BY: ____________________________ (Please print – Name and Job Title)

Phone Number: ___________________ Ext. __________________ Date: __________________

NSO is located at the Children’s Hospital of Eastern Ontario

January 27, 2017

Newborn screening manual
REFERENCES & APPENDICES
Appendix 7  Sample potential missed newborn screen alert and follow-up letter
Appendix 8  Sample test level unsat preliminary report

NEWBORN SCREENING ONTARIO
DÉPISTAGE NEONATAL ONTARIO

HOSPITAL
FAX: 123456789

PRELIMINARY REPORT

RE: TEST, TEST DECLINE
NSO Accession #: 200601013401
Mother’s Name: TEST CASE, MOM
Submitter Unique #: DOC: 1998-01-01 10:00

Health Card Number: 6968123833
Gender: Female
DOB: 1998-01-01 00:01

NSO Accession Number: 200601013401

This letter is to inform you that this sample was unsatisfactory for testing for DISEASE.

An unsatisfactory (UNSAT) result is displayed on the results report for DISEASE for this sample. A repeat sample is required as soon as possible.

Thank you for your assistance. If you have any questions or concerns about this letter, please call Newborn Screening Ontario at (613) 738-3222 x1045.

Sincerely,

Genetic Counsellor
Newborn Screening Ontario

Report enclosed for 200601013401

Version: April 1, 2014
## Appendix 9  CCHD Diagnostic Evaluation Report Form

### CCHD Diagnostic Evaluation Report Form

<table>
<thead>
<tr>
<th>Last Name:</th>
<th>First Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Card Number:</td>
<td>DOB:</td>
</tr>
<tr>
<td>CCHD Form Number:</td>
<td>Time of Birth:</td>
</tr>
<tr>
<td>NSO Episode Number:</td>
<td>Date of screen:</td>
</tr>
<tr>
<td>Screen performed by:</td>
<td>Time of screen(s):</td>
</tr>
<tr>
<td>Submitting Facility:</td>
<td>Age at first screen:</td>
</tr>
</tbody>
</table>

### Screen Results:

<table>
<thead>
<tr>
<th>Screen</th>
<th>SpO₂ R Hand</th>
<th>SpO₂ Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>First screen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second screen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third screen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Was the infant diagnosed:
- [ ] Prenatally
- [ ] Postnatally
- [ ] At/Post PO

### Was the infant symptomatic:
- [ ] Yes
- [ ] No
- [ ] Unknown

### Was the baby referred based on (check all that apply):
- [ ] Screening results
- [ ] Clinical status

### If referred based on PO screening results, was the algorithm correctly followed?
- [ ] Yes
- [ ] No

### Diagnostic Evaluation (check all that apply and complete relevant information):

#### Nurse practitioner

#### Family doctor

#### Emergency physician

#### Neonatologist

#### Paediatrician

#### Paediatric cardiologist

### Investigations (check all that apply and complete relevant information):

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Date</th>
<th>Outcome</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 limb BP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EKG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest Xray</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical examination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre and Post ductal PO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echocardiogram</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Referral within 6-8 hours?
- [ ] Yes
- [ ] No

### Assessment started within 6-8 hours?
- [ ] Yes
- [ ] No

### Decision for care (check all that apply and complete relevant information):

<table>
<thead>
<tr>
<th>Decision for care</th>
<th>Date/Time of discharge:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharged</td>
<td>Date/Time of admission:</td>
</tr>
<tr>
<td>Infant brought to hospital</td>
<td>Date/Time of decision:</td>
</tr>
<tr>
<td>Care provided in hospital, no transfer</td>
<td>Date/Time of decision:</td>
</tr>
<tr>
<td>Transfer within same hospital</td>
<td>Date/Time of transfer:</td>
</tr>
<tr>
<td>Transfer to another hospital</td>
<td>Date/Time of transfer:</td>
</tr>
</tbody>
</table>
CCHD Diagnostic Evaluation Report Form

If transferred, specify transfer to:
Transported by (check one):
- Transport team
- Ambulance w/o transport team
- Parents/Guardians
- Other, specify:

✓ Interventions (check all that apply):
- Oxygen
- Prostaglandin infusion
- Non-invasive positive pressure ventilation
- Intubation and ventilation

✓ Definitive Diagnosis (complete date and check one):

<table>
<thead>
<tr>
<th>Date diagnosis made:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventions</td>
</tr>
<tr>
<td>Oxygen</td>
</tr>
<tr>
<td>Prostaglandin infusion</td>
</tr>
<tr>
<td>Monitoring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary targets</th>
<th>Secondary targets</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoplastic left heart syndrome</td>
<td>Coarctation of the aorta</td>
<td>No disease identified Persistent low saturations, no definitive diagnosis</td>
</tr>
<tr>
<td>Pulmonary atresia w/ intact septum</td>
<td>Double outlet right ventricle</td>
<td></td>
</tr>
<tr>
<td>Tetralogy of Fallot</td>
<td>Ebstein anomaly</td>
<td>No disease identified Normal exam, normal saturations</td>
</tr>
<tr>
<td>Total anomalous pulmonary venous return</td>
<td>Interrupted aortic arch</td>
<td></td>
</tr>
<tr>
<td>Truncus arteriosus</td>
<td>Single ventricle</td>
<td>Other, specify:</td>
</tr>
<tr>
<td>Transposition of the great arteries</td>
<td>Pulmonary disease</td>
<td>Infant deceased prior to diagnosis Date of death: Cause of death:</td>
</tr>
<tr>
<td>Tricuspid atresia</td>
<td>Infection</td>
<td>Persistent Fetal Circulation</td>
</tr>
</tbody>
</table>

✓ Disposition (complete date and check one):

<table>
<thead>
<tr>
<th>Date disposition made:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge</td>
</tr>
<tr>
<td>Continue to follow with no treatment</td>
</tr>
<tr>
<td>Treatment recommended or initiated</td>
</tr>
<tr>
<td>Surgical</td>
</tr>
<tr>
<td>Medicine</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

Comments:

FORM COMPLETED BY: Date: RESPONSIBLE PHYSICIAN: If applicable, CARDIOLOGIST: