

*Report*

# Universal Newborn Hearing Screening 2012

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Prevention and Community Health  
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## Executive Summary

Approximately 86,000 infants are born in Washington State each year. Based on the national frequency of early hearing loss, we estimate that between 85 and 260 infants are born with hearing loss in Washington State annually. To prevent significant language, cognitive, and social delays, the Washington Early Hearing-loss Detection, Diagnosis, and Intervention (EHDDI) Program strives to ensure that:

- All newborns are screened for hearing loss *before one month* of age, preferably before hospital discharge.
- All infants who screen positive obtain a diagnostic audiologic evaluation *before three months* of age.
- All infants identified with a hearing loss receive appropriate early intervention (EI) services *before six months* of age.

Universal Newborn Hearing Screening (UNHS) is the first step towards the early identification of infants with hearing loss. Since 2006, all birthing hospitals in Washington perform UNHS. All but two military hospitals report their hearing screening results to the state EHDDI Program.

In 2012, the most recent year with complete statistics, there were 86,180 Washington births. Ninety six percent of these infants received newborn hearing screening with results reported to EHDDI and 168 infants were identified with congenital hearing loss. Seventy six of the 168 (45 percent) infants diagnosed with hearing loss were identified through the Early Support for Infants and Toddlers (ESIT) data system as receiving services. We were not able to obtain early intervention data on the remaining 92 infants diagnosed with hearing loss. Since 2012, we have linked our EHDDI information system (EHDDI-IS) with ESIT to improve our ability to evaluate whether infants with hearing loss are receiving timely intervention services.

Evaluation of the EHDDI program in 2012 revealed the following:

- Ninety six percent of infants received a newborn hearing screen with the average age of the final hearing screen at four days (range 0 to 286 days), well within the one-month goal.
- The average age at diagnosis for infants born in 2012 was 100 days (range 9 to 634), which does not meet our 90 day goal requiring continued quality improvement initiatives.
- The average age when EI services began for the 76 infants EHDDI linked with ESIT was 226 days (range 28 to 822). This does not meet the goal of children with hearing loss receiving EI services by six months (180 days) of age requiring continued quality improvement efforts.

In summary, significant progress in statewide newborn hearing screening has occurred but challenges remain. EHDDI Program staff continues to promote quality screening, timely referrals and better data reporting.

## Background Information

Congenital hearing loss has a relatively high prevalence compared to other conditions screened for at birth. According to national estimates, 1-3 of every 1,000 infants are born deaf or hard of hearing.<sup>i ii iii iv</sup>

National recommendations set forth by the Joint Committee on Infant Hearing in 2007 state: (1) all newborns will be screened for hearing loss before one month of age, preferably before hospital discharge, (2) all infants who screen positive will have a diagnostic audiologic evaluation before three months of age and, (3) all infants identified with a hearing loss will receive appropriate early intervention (EI) services before six months of age.<sup>v</sup> These are known as the “1-3-6 goals.” The Washington Early Hearing-loss Detection, Diagnosis, and Intervention (EHDDI) Program strives to meet these national goals.

Approximately 86,000 infants are born in Washington State each year.<sup>vi</sup> Based on the national frequency of early hearing loss, it is expected that between 85 and 260 infants are born with hearing loss in Washington State annually. Studies show that identifying these infants early and enrolling them in intervention services by six months of age contributes to age-appropriate language and cognitive development.<sup>vii viii ix</sup> Universal Newborn Hearing Screening (UNHS) is the first step towards early identification of infants with hearing loss. Prior to newborn hearing screening, the average age at the time of identified hearing loss in Washington was between 12 to 25 months of age.<sup>x</sup> Infants identified after six months of age are at increased risk for language, cognitive, and social delays that may require additional services and support.<sup>xi</sup> Since 2006, all birthing hospitals in Washington perform UNHS.

The economic cost of failing to identify infants in Washington who are deaf or hard of hearing and enrolling them in intervention continues to be defined. Recent national reports show that health, social, and broader societal costs in a given year were lower by 15 percent in areas with UNHS programs.<sup>xii</sup> While the difference was not statistically significant, it reflects the influence of early identification. A formal literature review (Sunrise Review) conducted by the Washington State Department of Health (DOH) in 2002 found that the fiscal benefits of the UNHS program are not seen in the health care system. However, societal and special education savings *are* significant.

Newborn hearing screening is typically performed at the hospital shortly after birth. The procedure may consist of Otoacoustic Emissions (OAE), a measure of inner ear function, Auditory Brainstem Response (ABR), a measure of the brain’s response to sound, or a combination of both screens. Infants who do not pass the newborn hearing screen are referred to a pediatric audiologist for a diagnostic evaluation involving physiologic and behavioral testing. For infants diagnosed with hearing loss, there are many management and long-term intervention services to consider.

This report outlines the EHDDI Program’s status in each of the five essential parts of newborn screening: screening, follow-up, diagnosis, management (EI), and evaluation.

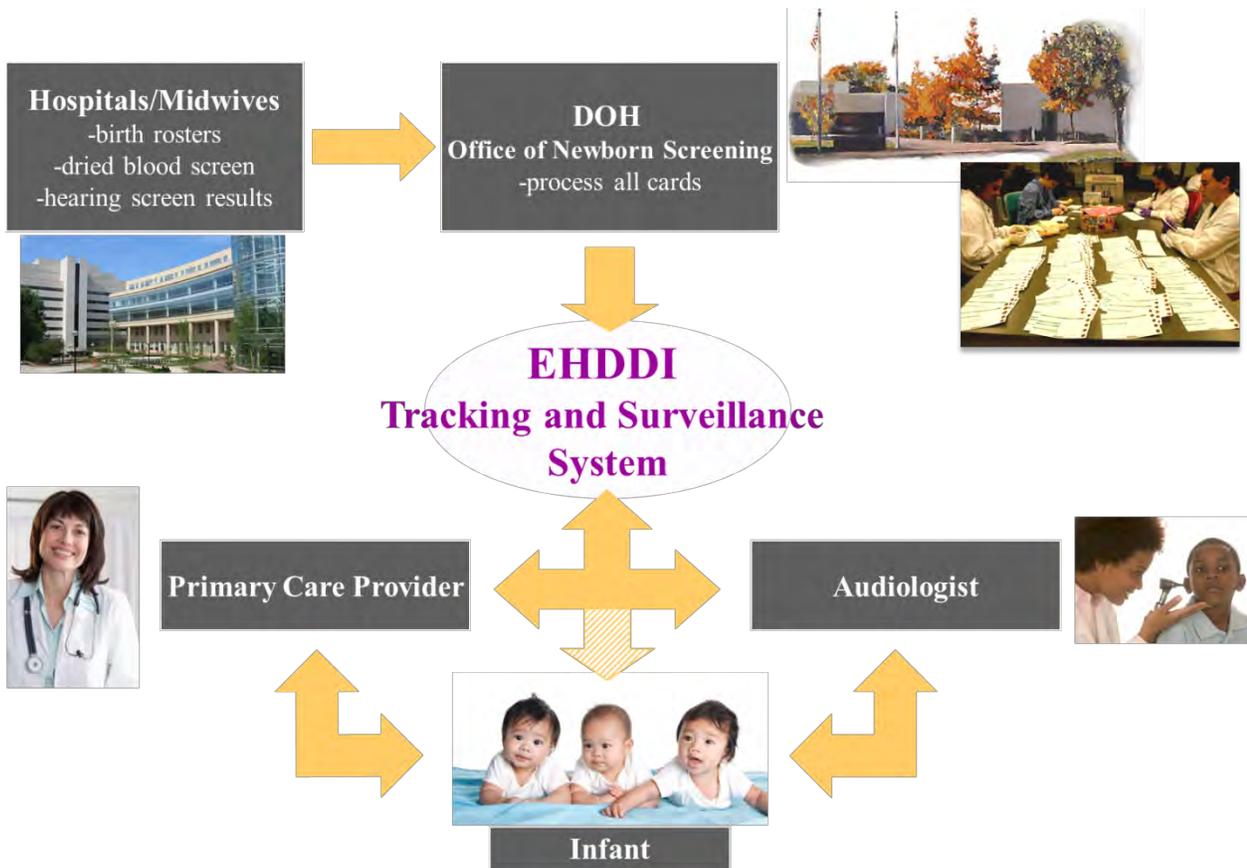
# Newborn Hearing Screening Schematic Overview

## UNIVERSAL NEWBORN HEARING SCREENING

**CORE FUNCTION:** PREVENTION of cognitive, language, and social delays

**METHOD:** POPULATION BASED SCREENING of all newborns carefully coordinated with providers at birthing facilities, and primary, and specialty care clinics.

**FOCUS:** HEARING LOSS that would go undetected without screening



## Universal Newborn Hearing Screening

**Table I: 2012 Births by Facility and County of Occurrence – Infants Screened for Hearing Loss by County of Occurrence**

County	Hospital Births	Federal Facility	Other	Out-of-Hospital Births	Total Births	Screened	% Screened
Adams	537	0	0	1	538	533	99%
Asotin	0	0	0	1	1	0	0%
Benton	4255	0	4	56	4315	4196	97%
Chelan	1391	0	1	53	1445	1398	97%
Clallam	560	0	2	40	602	568	94%
Clark	5119	0	3	107	5229	5100	98%
Columbia	0	0	0	0	0	0	NA
Cowlitz	1028	0	0	8	1036	1011	98%
Douglas	0	0	0	5	5	0	0%
Ferry	0	0	0	2	2	0	0%
Franklin	398	0	0	20	418	395	94%
Garfield	0	0	0	0	0	0	NA
Grant	1212	0	1	16	1229	1191	97%
Grays Harbor	576	0	0	5	581	568	98%
Island	153	364	1	44	198 <sup>a</sup>	166	84%
Jefferson	79	0	0	23	102	82	80%
King	28,401	0	8	916	29,325	28,284	96%
Kitsap	1946	815	4	51	2001 <sup>a</sup>	1938	97%
Kittitas	364	0	0	5	369	362	98%
Klickitat	21	0	0	13	34	20	59%
Lewis	643	0	1	67	711	646	91%
Lincoln	0	0	0	3	3	0	0%
Mason	276	0	1	6	283	275	97%
Okanogan	477	0	0	19	496	487	98%
Pacific	0	0	2	1	3	0	0%
Pend Oreille	92	0	0	3	95	90	95%
Pierce	9043	2531	9	360	11,943	11,481	96%
San Juan	0	0	0	2	2	1	50%
Skagit	1515	0	3	125	1643	1521	93%
Skamania	0	0	0	1	1	0	0%
Snohomish	5710	0	4	311	6025	5703	95%
Spokane	6667	0	6	206	6879	6649	97%
Stevens	264	0	1	25	290	255	88%
Thurston	2818	0	5	151	2974	2864	96%
Wahkiakum	0	0	0	0	0	0	NA
Walla Walla	841	0	0	28	869	835	96%

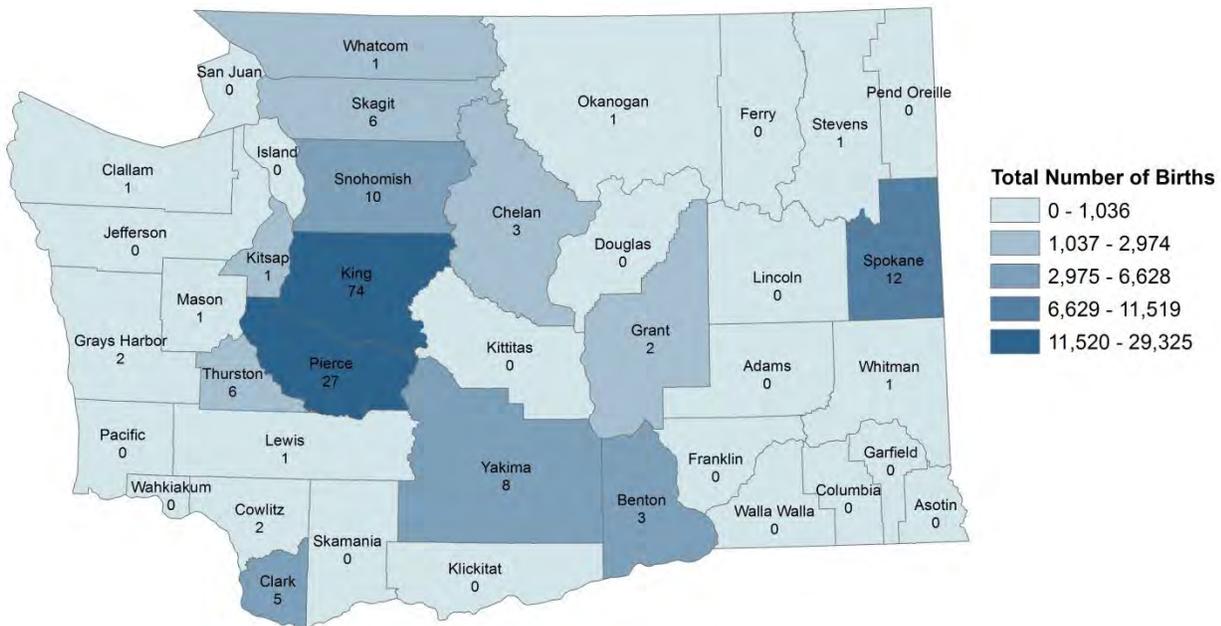
County	Hospital Births	Federal Facility	Other	Out-of-Hospital Births	Total Births	Screened	% Screened
Whatcom	2005	0	1	154	2160	2125	98%
Whitman	494	0	0	4	498	492	99%
Yakima	3851	0	0	24	3875	3764	97%
State Total	80,736	3710	57	2856 <sup>a</sup>	86,180	83,000	96%

a. Excludes infants born in military hospitals that do not participate in the Newborn Screening Program (364 born at Oak Harbor Naval Hospital and 815 born at Bremerton Naval Hospital). Total excluded =1179.

### Infants Diagnosed with Hearing Loss

According to diagnostic results reported to the EHDDI Program by audiologists, 168 infants born in 2012 were diagnosed with hearing loss. One hundred fifty six of these infants were referred to audiology because of their newborn hearing screen. Five infants passed their newborn hearing screening, but received diagnostic evaluations due to risk factors associated with late onset hearing loss. Four infants passed their initial screen, but did not pass a subsequent screen and were referred to audiology. Three infants diagnosed with hearing loss passed their newborn hearing screening and were referred to audiology for unknown reasons.

**Figure I: 2012 Infants Diagnosed with Hearing Loss by County of Occurrence**



\*Excludes infants born in military hospitals that do not participate in the Newborn Screening Program (364 born at Oak Harbor Naval Hospital and 815 born at Bremerton Naval Hospital). Total excluded =1179.

**Table II: 2012 Infants Detected with Hearing Loss by Race**

<b>Infant's Race<sup>a</sup></b>	<b>Total Births</b>	<b>Infants Diagnosed with Hearing Loss</b>
White	56,286	86
African American	6419	7
Asian	10,844	19
Native American	2536	3
Other <sup>b</sup>	10,095	17
Unknown	0	36
<b>Total<sup>c</sup></b>	<b>86,180</b>	<b>168</b>

Hispanic <sup>d</sup>	19,429	40
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a The infant's race for 2012 is from birth certificate data and was determined by an algorithm of mother and father's race developed by the National Center for Health Statistics. The race of infants detected is from information provided on the newborn screening test form.

b Reflects Hispanic race and multiracial (more than one race designation on the screening form).

c Excludes infants born in military hospitals that do not participate in the Newborn Screening Program (364 born at Oak Harbor Naval Hospital and 815 born at Bremerton Naval Hospital). Total excluded =1179.

d Hispanics can be of any race; they are included in the figures above.

### **EHDDI Follow-up Procedures**

Hospitals, clinics, and midwives report newborn hearing screening results to the EHDDI Program on revised Newborn Screening blood spot cards. Demographic data and hearing screening results from the cards are entered into the EHDDI-Information System (IS). Diagnostic results for infants referred to audiology are reported by audiologists on either a form that is faxed to the EHDDI Program or reported by audiologists directly into EHDDI-IS via our web application on Secure Access Washington (SAW).

Based on the hearing screening and diagnostic results reported, EHDDI-IS generates appropriate actions and reports for EHDDI Program staff to complete. These include:

- Faxing an infant's Primary Care Provider (PCP) with recommendations for appropriate follow-up and requesting additional information from the PCP.
- Calling an infant's PCP if the PCP has not responded to faxes sent.
- Sending a letter and resources to families who have not brought their infant to an audiologist for a recommended diagnostic evaluation.
- Faxing hospitals a "Possible No Test Report," that lists infants born at the hospital who do not have a hearing screen result reported to the EHDDI Program.
- Faxing hospitals a "Did Not Pass – No Record of Rescreen Report," that lists infants born at the hospital who did not pass their initial hearing screen and do not have a second hearing screen

reported to the EHDDI Program.

- Faxing audiologists a “Pending Diagnostic Evaluation Report,” that lists infants referred to their clinic who do not yet have a conclusive diagnostic evaluation.

Infants diagnosed with hearing loss should be referred to the Early Support for Infants and Toddlers (ESIT) Program. ESIT provides services for infants and toddlers who have disabilities, including hearing loss. Once a family is referred to ESIT, it is connected with a family resource coordinator who works with the family to develop an Individual Family Service Plan (IFSP). The IFSP is completed within 45 days from the referral to ESIT and outlines the specialized training, counseling, and EI services the family will receive to meet the unique communication needs of their child.

In 2014, the EHDDI Program established an electronic linkage with the ESIT database. This linkage allows audiologists to refer infants to the ESIT Program through EHDDI-IS. It also allows EHDDI-IS to receive EI information from ESIT for infants referred through the EHDDI-IS and for infants who are identified as having hearing loss in the ESIT system even if they were not referred through the EHDDI-IS.

### Early Intervention

In 2012, 45 percent (76 of the 168) of infants diagnosed with hearing loss in EHDDI-IS were indicated as having a hearing loss in the ESIT data system. We were not able to obtain EI data on the remaining 92 infants who were diagnosed with hearing loss.

**Table III: EI Services by Age and Type of Service as noted in the IFSP.** (Note: more than one EI service can be indicated in an infant’s IFSP.)

EI Service	Number of Infants	Age EI Service Began (Days)	
		Average	Range
Assistive Technology Devices and Services	28	184	62 - 467
Family Training, Counseling, and Home Visits	18	222	48 - 802
Hearing Services	8	274	92 - 573
Nutrition Services	2	123	46 - 200
Occupational Therapy	5	359	108 - 684
Physical Therapy	2	108	78 - 138
Service Coordination	14	201	50 - 572
Special Instruction	55	233	62 - 822
Speech/Language Pathology	14	227	28 - 612

## Evaluation of Newborn Hearing Screening, Diagnosis, and Intervention

### SCREENING

All infants should receive newborn hearing screening before one month of age. This includes an initial screen *and* a second screen if the infant does not pass his or her initial screen. In 2012, 96 percent of infants born in Washington State received a newborn hearing screen. The average age of the final hearing screen was 4 days (range 0 to 286 days). This is well within the one-month goal for most infants.

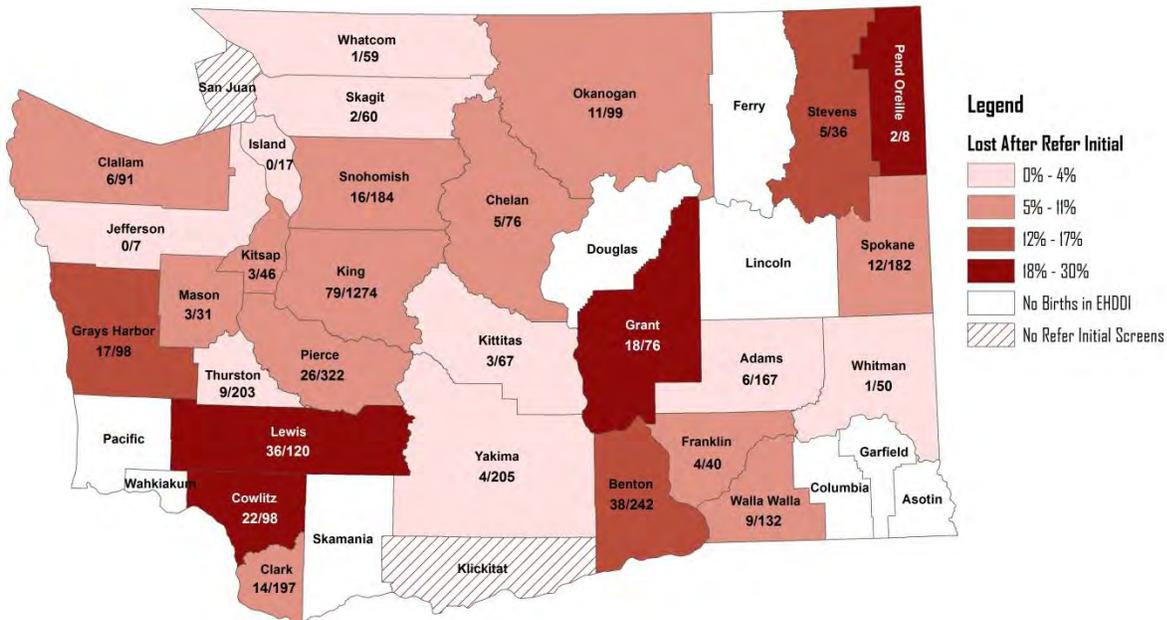
While Washington EHDDI is considered a national leader regarding infants receiving their newborn hearing screening before one month of age, challenges remain.

- Only 24 percent (698/2856) of out-of-hospital births in 2012 received newborn hearing screening. Over the past several years, EHDDI Program staff has helped midwives acquire hearing screening equipment, including training midwives to use the equipment, and offered ongoing educational support. Compared to 2008, when only 7 percent (151/2058) of out-of-hospital births had a reported hearing screen, clearly 24 percent is an improvement. But, Washington still has a significant number of infants born out-of-hospital who do not receive hearing screens.
- Twenty seven percent (326/1221) of infants who miss their initial screen at the hospital never receive a hearing screen. Of note, 30 percent (98/326) of these infants who did not receive screening after missing their hearing screen at the hospital were born at either Sunnyside Community Hospital or Overlake Medical Center. These are the only two hospitals in the state that do not screen infants before hospital discharge and have a protocol of outpatient initial hearing screens, requiring families to return to the hospital for screening.

In 2012, 5 percent (4187/83,945) of the infants the EHDDI Program tracked did not pass their initial hearing screen. Of these infants, 8 percent (352/4187) did not receive a needed second hearing screen. In 80 percent (251/352) of these cases, the infant's PCP shared with the family that the infant needed a rescreen, but either the family did not bring their child in for a rescreen or the screening result was not reported to the EHDDI Program.

Figure II illustrates the percent infants lost to follow-up after not passing their initial hearing screen in each county. Counties with the highest loss to follow-up (between 18 percent and 30 percent) are generally those with hospitals that have a high percentage of infants who do not pass their initial screen and/or do not perform outpatient rescreens at the hospital. For example, St. John Medical Center in Cowlitz County screens with ABR and does not do rescreens. Providers in the community (Longview) are responsible for rescreens. Providence Centralia Hospital in Lewis County does not pass 19 percent of infants on their initial screen and does not do rescreens at the hospital. In Grant County, 11 of the 18 infants who did not receive a second screen after not passing their initial hearing screen were born at Coulee Medical Center, which does not pass 27 percent of infants at initial screen. These examples illustrate how poor quality initial hearing screening and/or the lack of access to easy repeat hearing screening contribute to higher loss to follow-up rates.

**Figure II: Percent of infants lost to follow-up after not passing their initial screen by county.**  
 (Note: Because the numbers are small, the numerator and denominator are also provided.)



**DIAGNOSIS**

Infants who do not pass screening should have a comprehensive audiological evaluation at no later than three months of age (90 days). The average age at diagnosis for infants born in 2012 was 100 days (range 9 to 634), which does not meet our 90 day goal. Not only does a later diagnosis delay EI services, but infants older than three months of age usually require sedation in order to obtain an accurate diagnostic result. Sedation causes a great deal of anxiety for families and often causes them to delay their infant’s evaluation until the child is much older and can be diagnosed using behavioral testing. EHDDI Program staff continues to educate providers and audiologists on current best practices guidelines that will help ensure infants receive a full diagnostic assessment by three months of age.

The EHDDI Program tracked 579 infants born in 2012 who were referred to audiology after not passing their hearing screening. Two hundred sixty seven (46 percent) of these infants were found to not have a hearing loss and 156 (27 percent) were diagnosed with a hearing loss. This represents a prevalence of 1.9 per 1000, which is within the expected range of 1-3 per 1000. However, 156 infants (27 percent) referred to audiology have not yet received a conclusive diagnosis. There are a variety of reasons why EHDDI might not have a diagnosis on record. The audiological evaluation may not have been completed if an infant was crying or agitated, requiring parents to return at a later time to complete the testing. In addition, a family may move or, tragically, the infant may die. At times, the diagnostic evaluation is completed, but the audiologist fails to report the findings to EHDDI-IS. This is often referred to as “loss-to-documentation.” Figure III illustrates the EHDDI Program’s current follow-up information for these infants.

**Figure III: Status of infants born in 2012 referred to audiology, but EHDDI has no diagnosis on record.**

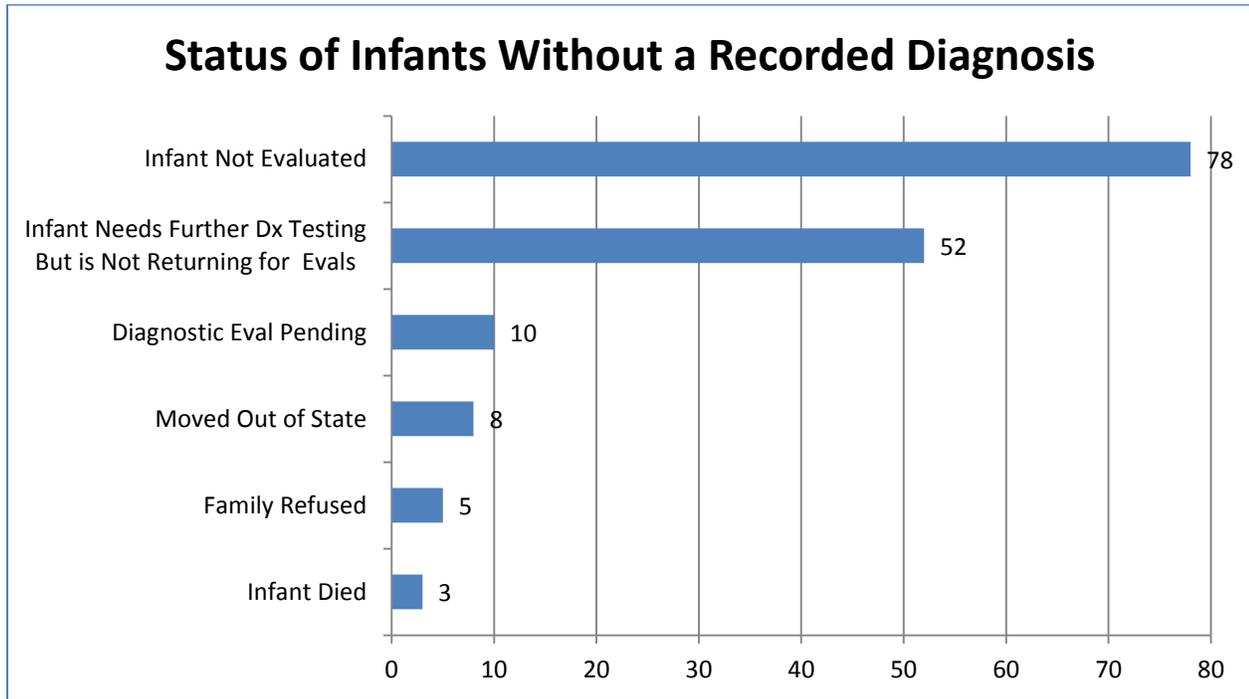
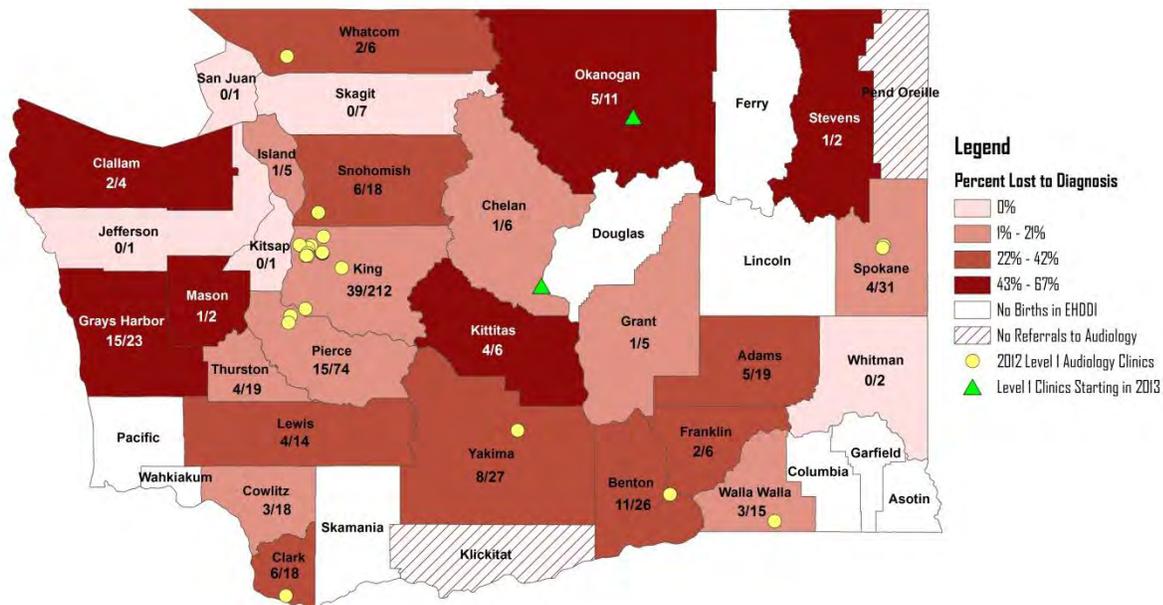


Figure IV illustrates geographically the percent of infants born in 2012 who were lost to follow-up or lost to documentation after being referred for a diagnostic evaluation. The dots on the map indicate the Level 1 Audiology Clinics in 2012. Level 1 clinics provide complete diagnostic testing for infants birth to six months of age. Counties with the highest loss to follow-up (between 43 percent and 67 percent) are generally those furthest away from Level 1 clinics. For example, the closest Level 1 clinic for infants born at Grays Harbor Community Hospital in Grays Harbor County is 80.4 miles, with an estimated driving time of 1 hour and 37 minutes. The time and cost of this travel poses a substantial barrier for families.

**Figure IV: Percent of infants lost after referral for audiologic evaluation by county (excludes infants who died).** (Note: Because the numbers are small, the numerator and denominator are also provided.)



**INTERVENTION**

The EHDDI Program was only able to link 76 of 168 infants with hearing loss to records in the ESIT system. We believe that many of the 92 infants we were not able to link are receiving EI services. Their records were not sent to EHDDI-IS because they were not indicated as having a hearing loss in the ESIT data system. We are working to solve this issue by training audiologists to use EHDDI-IS to directly refer infants to ESIT. EHDDI-IS would then automatically get EI information. In addition, we are training the ESIT data system users to always indicate hearing loss as a diagnosis in a child’s record if one is present. EHDDI-IS would then receive EI information even if the child was not referred through EHDDI-IS.

Infants who are diagnosed with hearing loss should receive EI services by six months of age. The average age when EI services began for the 76 infants EHDDI linked with ESIT was 226 days (range 28 to 822). This does not meet the goal of children with hearing loss receiving EI services by six months (180 days) of age. The EHDDI Program is working with audiologists and our partners in the ESIT program, Center for Childhood Deafness and Hearing Loss, and Office of the Deaf and Hard of Hearing to determine what strategies can be implemented to ensure infants with hearing loss receive EI services before six months of age.

## **Collaborative Efforts Supporting Universal Newborn Hearing Screening in Washington**

The efforts to support and sustain voluntary UNHS are collaborative and multi-faceted. Below are some of the groups in Washington involved in these efforts and their contributions to UNHS.

### *American Academy of Pediatrics (AAP)*

The AAP promotes the health and well-being of children and works to ensure that children receive quality care through a medical home. DOH works with Washington State's designated AAP Chapter Champion, Dr. Jeffrey Stolz, to educate providers about newborn hearing screening and services available for children with hearing loss.

### *Audiologists*

Audiologists provide the critical step in identifying infants who are deaf or hard of hearing by performing diagnostic evaluations on infants who do not pass their hearing screen. Audiologists also assist DOH in reviewing proper protocols in hearing screening and diagnostic evaluation. Finally, audiologists work with DOH to collect and report diagnostic results through a secure Web-based extension of DOH's tracking and surveillance system.

### *Birthing Hospitals*

UNHS programs are located within individual birthing hospitals. At the end of 2006, all Washington birthing hospitals had implemented UNHS programs. Hospital staff is responsible for nearly all aspects of UNHS program development and maintenance. This includes:

- Determining their screening protocol from options shared by DOH.
- Determining procedures.
- Training screening staff.
- Recording and reporting results.
- Financing the program.
- Obtaining and caring for screening equipment.
- Communicating with parents, DOH, and primary care providers.

All but the two naval hospital UNHS programs are coordinating efforts with the EHDDI Program to collect and report hearing screen results. These hospitals (approximately 1200 births) are required by the Navy to use PerkinElmer's laboratory and follow-up services for newborn "dried blood spot" screening. Since DOH's newborn hearing screening tracking and surveillance system is integrated with Washington State's metabolic screening program, coordination between the naval hospitals and the EHDDI Program is not feasible at this time.

### *Center for Childhood Deafness and Hearing Loss (CDHL)*

CDHL collaborates with the Office of Superintendent of Public Instruction, educational service districts, local school districts, and other public and private agencies to provide statewide leadership for the coordination and delivery of educational services for children who are deaf, deaf-blind, and hard of hearing, including the full range of communication modalities.

### *Hands and Voices*

Hands and Voices is an organization dedicated to supporting families by providing non-biased information about communication options and access to services and education. They strive to

empower deaf, hard-of-hearing, and deaf-blind children in Washington to reach all of their future goals. Since 2009, DOH has contracted with the Washington State Chapter of Hands and Voices to support its Guide By Your Side™ (GYBS) program. GBYS offers trained parent guides to help families navigate through systems, link families with local and national parent-to-parent resources, and assist parents with advocating for their child in health care and school settings.

*Seattle Children's Hospital*

DOH contracts with Seattle Children's audiologists and staff to provide on-going technical assistance to hospital-based UNHS programs. This audiologist makes site visits to hospitals, conducts annual UNHS manager trainings, and works with DOH staff to develop and distribute professional and parent educational materials.

*Washington Sensory Disabilities Services (WSDS)*

WSDS provides information, training, technical assistance, and resources to families and educators statewide regarding individuals from birth to 21 years of age with sensory disabilities - people who are deaf, hard of hearing, visually impaired, blind, or deaf-blind. DOH also works with WSDS to provide training and support to Head Start programs to improve hearing screening practices for children 0-5 years of age.

*Washington State Department of Early Learning (DEL)*

DEL's Early Support for Infants and Toddlers program works with other state agencies to maintain a statewide system of early intervention services that families may need for their infants or toddlers with disabilities. Family resource coordinators (FRCs) in each county help families get services and information.

*Washington State Department of Social and Health Services (DSHS)*

The Office of the Deaf and Hard of Hearing (ODHH), within DSHS, provides services to the deaf, hard of hearing, and deaf-blind communities throughout Washington State. ODHH contracts with six community service centers located in Seattle, Tacoma, Vancouver, Pasco, Spokane, and Bellingham to provide communication access, advocacy, sign language interpreter information, workshops, information and referral, counseling, outreach, and independent living support services to clients and their families.

*Washington State Hospital Association (WSHA)*

WSHA provides leadership, advocacy, and support to Washington hospitals. WSHA plays a critical role in encouraging hospitals to establish and maintain voluntary UNHS programs.

## Appendix A

### *Washington State Department of Health*

# Protocol for Newborn Hearing Screening

## Overview

The purpose of a screening test is to identify infants at-risk for hearing loss who need further testing. A screening test is not a diagnosis. The Washington State Early Hearing-loss Detection, Diagnosis and Intervention (EHDDI) Program recommends screening all infants for hearing loss before one month of age. This protocol includes guidance from the Joint Committee on Infant Hearing (JCIH) 2007 position statement<sup>1</sup>. Initially a workgroup including audiologists, hospital nurses, and other health professionals from across Washington developed this protocol. EHDDI Program staff then revised the protocol and asked audiologists and hospital screening staff to review it before finalizing it.

### **1a. Initial Hearing Screening—Well Baby Nursery**

- For the initial screening, use one of the following:
  - Evoked Otoacoustic Emissions (EOAE, OAE, TEOAE, DPOAE).
  - Auditory Brainstem Response (ABR, AABR, BAER, ABAER).
  - A combination of both measures.<sup>1</sup>
- The birth hospital typically performs the initial screen while the baby is still an inpatient. Perform the screen as close to discharge as possible, preferably 12 hours or more after birth. The screening may be done sooner if needed; however, a higher referral rate may occur due to residual birthing debris in the ear canal.
- For OAE: If the infant does not pass on the first try, take the probe out of the ear and look at whether it is clogged with wax or debris. Wipe the probe tip if necessary, reinsert the probe and run the test again. Not all babies will pass, so only make two attempts.
- For ABR: If the infant does not pass on the first try, check that electrodes are secure, positioning of the earphone or probe is correct, electrodes are oriented away from the top of the baby's head, and wires are not crossed. Not all babies will pass, so only make two attempts. These two attempts make up the "initial" hearing screen.
- If the infant does not pass the first screening, perform a second screening, if time allows before hospital discharge. In each screening session, make only two attempts per ear. If the first screening used an OAE, use either an OAE or ABR for the second screening. If the first screening used an ABR, use an ABR for the second screening. Rescreen both ears even if only one ear did not pass initially.
- Refer the infant for an outpatient rescreen (step 2) if:

- S/he does not pass the initial screening, or
  - Results cannot be obtained in one or both ears.
- \*\* If an outpatient rescreening is not utilized, then a referral to diagnostic evaluation is appropriate. Skip to step 3.

### **1b. Initial Hearing Screening—NICU**

- Infants admitted to the neonatal intensive care unit (NICU) for more than five days need to have an automated ABR included as part of their hearing screening to avoid missing a neural hearing loss.
- Refer infants who do not pass automated ABR screening in the NICU directly to an audiologist for rescreening (rather than having an outpatient rescreen at the hospital) and, when indicated, comprehensive audiologic evaluation including ABR (steps 2 and/or 3).

## **2. Rescreening**

- Rescreen infants who do not pass the initial hearing screen in one or both ears.
- Rescreen after discharge to allow sufficient time for the infant’s ears to clear of residual birthing debris.
- The rescreening should occur prior to one month of age.
- The birth hospital typically performs the rescreen on an outpatient basis.
  - If the initial test used an OAE, rescreen with Otoacoustic Emissions (EOAE, OAE, TEOAE, DPOAE), Auditory Brainstem Response (ABR, AABR, BAER, ABAER), or a combination of both measures.
  - If the initial test used ABR, rescreen with only ABR to avoid missing a neural hearing loss.
- Rescreen both ears even if only one ear did not pass the initial screen.
- The rescreening should occur in a single visit, with two attempts maximum on each ear. These two attempts make up the “rescreen.”
- Refer an infant for a diagnostic audiological evaluation if:
  - She or he does not pass the rescreening, or
  - Results cannot be obtained in one or both ears.

## **3. Referrals for Diagnostic Audiological Evaluation**

- Refer an infant for a diagnostic audiological evaluation after failure to pass the initial hearing screen and the rescreen in one or both ears. Do not continue to screen further.
- An audiologist trained in infant diagnostic audiological evaluation should perform the evaluation. See the Washington State Department of Health Diagnostic Audiology Best Practice Guidelines<sup>2</sup> for details.

- The infant's primary care physician may coordinate the referral for diagnostic evaluation.
- The diagnostic evaluation should occur prior to three months of age.

#### **4. Assessment of Risk Factors for Late Onset Hearing loss**

A passed newborn hearing screening means a significant hearing loss is unlikely. However, hearing loss can develop or worsen later in infancy and childhood for many reasons. It is important to assess for and report on the five risk factors for hearing loss listed on the pink and blue hearing screening cards as accurately as possible. Infants with these risk factors need appropriate follow up. The risk factors are:

1. Stay in neonatal intensive care unit (NICU) > five days.
2. Stigmata or other findings associated with a syndrome known to include hearing loss.
3. Family history of permanent childhood sensorineural hearing loss.
4. Craniofacial anomalies.
5. In-utero infections including toxoplasmosis, rubella, cytomegalovirus (CMV), herpes and syphilis .

If a baby has one or more of these risk factors, mark the appropriate box(es) on the pink or blue hearing screening card. The EHDDI Program will follow up with the primary care provider for risk factors 2 through 5. The Joint Committee on Infant Hearing 2007 Position Statement recommends a diagnostic audiologic evaluation by age 24-30 months for infants who pass their newborn hearing screen but have one or more risk factor(s) for late onset or progressive hearing loss.

#### **5. Documentation and Communication of Screening Results**

- Record screening results in the infant's medical record.
- Clearly communicate screening results to the infant's parents verbally and in writing. Provide results and hearing screening information to families in their preferred language.
- Communicate screening results to the infant's primary care provider in writing.
- Report screening results to the Department of Health (DOH) on the newborn hearing screening cards. Send results to DOH every week. For more information on reporting screening results to DOH, please contact the program at 206-418-5613 or 1-888-WA-EHDDI.
- Give parents written information about risk factors for hearing loss and typical language development.

#### **6. Quality Assurance**

- Within three months of initiating a hearing screening program:
  - Maintain a referral rate no higher than 8 percent for the initial screening.
  - If the hospital performs outpatient rescreening, maintain a referral rate no higher than 4

percent.

- Within six months of program initiation, screen a minimum of 95 percent of infants prior to discharge or before one month of age.
- The benchmark for percent of infants lost after not passing the initial screen should be 10 percent or less.
- Institute a tracking system to monitor referral rates and to assist in the follow up of infants referred for a rescreen or diagnostic evaluation.
- For free technical assistance in newborn hearing screening program planning and development, contact the Seattle Children's Hospital Newborn Hearing Screening Project Team.<sup>4</sup>

## 7. Screener Requirements

- Screeners should have adequate skills in soothing and calming newborns.
- An audiologist or someone similarly trained in screening techniques should train screeners.
- Train screeners how to communicate results to families in a sensitive and culturally competent manner. Keep laminated examples of proper hearing screening terminology and language with the screening equipment for immediate reference.
- Train screeners to answer parents' questions about newborn hearing screening. When screeners do not know the answers, they should know where to refer the family for answers.

## 8. References

- <sup>1</sup> Joint Committee on Infant Hearing (2007). Year 2007 Position Statement: Principles and guidelines for early hearing detection and intervention programs. *Pediatrics* 120 (4), 898-921. Or <http://jcih.org/>.
- <sup>2</sup> Basic steps for each test: <http://here.doh.wa.gov/materials/nb-screening-steps-oae-testing> and <http://here.doh.wa.gov/materials/nb-screening-steps-abr-testing>
- <sup>3</sup> Diagnostic Audiology Best Practice Guidelines: [http://www.doh.wa.gov/Portals/1/Documents/Pubs/344-016\\_EHDDIAudioProtocol.pdf](http://www.doh.wa.gov/Portals/1/Documents/Pubs/344-016_EHDDIAudioProtocol.pdf)
- <sup>4</sup> For free technical assistance in newborn hearing screening program planning and development, contact:

Seattle Children's Hospital  
Universal Newborn Hearing Screening Project  
4800 Sand Point Way NE, W-6640  
Seattle, WA 98105

Phone: 206-987-2457  
Fax: 206-987-1004  
Email: [UNHS@seattlechildrens.org](mailto:UNHS@seattlechildrens.org)

For general information regarding newborn hearing screening or follow-up, contact:

Early Hearing-loss Detection, Diagnosis and Intervention (EHDDI) Program  
1610 NE 150th Street  
Shoreline, WA 98155  
Phone: 206-418-5613  
Toll-free: 1-888-WA-EHDDI  
Fax: 206-418-5415  
Email: [Ehddi2@doh.wa.gov](mailto:Ehddi2@doh.wa.gov)  
[www.doh.wa.gov/earlyhearingloss/provider](http://www.doh.wa.gov/earlyhearingloss/provider)

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## Appendix B

### Washington State Department of Health

# Protocol for Diagnostic Audiological Assessment: Follow-up for Newborn Hearing Screening

## Overview

The Washington State Early Hearing-loss Detection, Diagnosis and Intervention (EHDDI) Program recommends that infants who do not pass their newborn hearing screening have a diagnostic audiological assessment before three months of age. In addition, infants who do pass the neonatal screening, but have one or more risk factors for late onset or progressive hearing loss, should have at least one diagnostic audiological assessment by 24 to 30 months of age. Frequency of diagnostic follow-up depends on the specific risk factor and/or parental concern. Early and more frequent assessment may be indicated for children with cytomegalovirus (CMV) infection, syndromes associated with progressive hearing loss, neurodegenerative disorders, trauma, or culture-positive postnatal infections associated with sensorineural hearing loss; for children who have received extracorporeal membrane oxygenation (ECMO) or chemotherapy; and when there is caregiver concern or a family history of hearing loss.

This protocol includes guidance from the Joint Committee on Infant Hearing (JCIH) 2007 position statement. A workgroup of 22 audiologists who see infants born in Washington revised the protocol in June 2011. Workgroup members have extensive knowledge and expertise in the screening and diagnosis of hearing loss in newborns and infants.

The recommendations in this document pertain specifically to follow-up from newborn hearing screening, and may differ from those for other purposes. The focus of the diagnostic test components is physiologic assessment. Behavioral audiometry may be appropriate for infants at developmental age of six months and over if reliable ear-specific information is obtained.

## Diagnostic test components

This protocol describes how to 1) obtain an estimate of hearing sensitivity across the speech frequency range; 2) determine the type of hearing loss if there is a hearing loss; 3) provide a starting point for habilitation services such as amplification; and 4) provide a baseline for further monitoring. A comprehensive assessment should include both ears even if only one ear did not pass the screening test. Comprehensive evaluations should be completed by audiologists experienced in pediatric hearing assessment.

The auditory brainstem response (ABR) is the core component in assessing young infants because the audiologist can usually obtain accurate, frequency-specific and ear-specific pure tone threshold estimates with this technique. However, otoacoustic emissions (OAE) and middle ear assessments are also mandatory. After completing otoscopy, the order of procedures (ABR, OAE, immittance) is up to the discretion of the audiologist.

Begin by:

- Obtaining hospital screening results and a medical history, including the presence of any risk indicators (see Appendix A at end of this document).

- Performing an otoscopic evaluation.

### ABR Procedures

- Attach electrodes to the baby using a 2-channel montage: high forehead (non-inverting); each mastoid process (inverting); lateral forehead (common).
- Have the caregiver feed the infant if necessary, to induce natural sleep. Diagnostic ABR requires a sleeping baby. Infants under six months of age can often be tested while sleeping naturally. This typically does not work with older infants, who may need to see a provider who can give sedation.
- Prioritize the test stimulus order and level to obtain the most information in the shortest amount of time. To obtain frequency-specific estimates of hearing thresholds, begin with tonebursts, though in some cases it may help to start with or switch to a click. See Appendix B at the end of this document for stimulus and recording parameters.
- Perform frequency-specific ABR using unmasked Blackman-gated tonebursts presented via insert earphones. When feasible, insert both earphones at the start of testing to make switching between ears easy.
- Begin with a 2000 Hz toneburst at or near the minimum stimulus level required to classify hearing as normal. See Appendix B. If no response is detected, increase stimulus level by 20-30 dB. If response is present, descend in 10 dB steps until you find the threshold.
- Proceed to a 500 Hz toneburst.
- If time permits, consider obtaining results for 4000 Hz and 1000 Hz tonebursts for each ear (based on results).
- If indicated and feasible, perform bone conducted ABR on each ear using a click. Tonebursts at 2000 and 500 Hz may be used as time permits.
- Perform click-evoked ABR if the infant has elevated or “no response” on toneburst ABR (see Neurodiagnostic parameters in Appendix B).

### OAE Procedures

In evaluating OAEs, perform the following procedures in conjunction with ABR as a cross check for determining outer hair cell function. OAEs are not a substitute for ABR. Note that these procedures for diagnostic assessment differ from parameters for OAE screening because the audiologist determines the protocol and interprets the results (i.e., the result is not a “pass” or “refer”). See DOH document, “Protocol for Newborn Hearing Screening”, found at [www.doh.wa.gov/Portals/1/Documents/Pubs/344-023\\_EHDDINBScrnProto.pdf](http://www.doh.wa.gov/Portals/1/Documents/Pubs/344-023_EHDDINBScrnProto.pdf), for screening parameters. Either or both of the following OAE tests may be used.

#### Transient Evoked Otoacoustic Emissions (TEOAE)

- Complete at least 60 runs.

- Start testing at 80 dB peSPL, and go up to 86 or down to 74 after that, depending on initial results.
- For TEOAEs to be considered present and normal, the response must have a minimum of a 3 dB SNR (signal to noise ratio) and 70 percent reproducibility at any particular frequency band. In addition, the overall response amplitude should fall within the range typical for normal hearing children of comparable age.

#### Distortion Product Evoked Otoacoustic Emissions (DPOAE)

- Stimulus levels L1=65 dB SPL, L2=55 dB SPL or L1=65 dB SPL, L2=50 dB SPL.
- DPOAE data interpretation is very equipment-specific. The minimum SNR needed for a response to be considered present depends on how the equipment manufacturer calculates the noise floor.
- In general, DPOAEs are considered to be present and normal if the response SNR is > 3 to 6 dB at the majority of frequency bands tested and the overall response amplitude falls within the range typical for normal hearing children of comparable age.

#### Immittance Procedures

Obtain acoustic immittance measures (using a 1000 Hz probe tone if the infant is six months or younger). Incorporate an immittance battery with caution due to the difficulty in classifying tympanometric measures numerically—tympanograms obtained with a 1000 Hz probe tone require visual interpretation. The acoustic reflex can be a useful part of the audiologic test battery in infants. A present reflex adds support for determining normal middle ear function and provides a cross check for ABR measurements. It is also important to use a high-frequency probe to measure the acoustic reflex in infants less than six months of age. For infants older than four months, the immittance battery becomes more reliable and valid. For all ages, obtain a tympanogram with a 226 Hz probe tone to estimate ear canal volume.

#### **Referrals**

- Infants identified with hearing loss should be fit with appropriate amplification if the family chooses this option and see an ENT for medical/surgical care. A Family Resources Coordinator (FRC) can help families enroll children into the Early Support for Infants and Toddlers (ESIT) Program and early intervention services. Children should receive regular audiologic follow-up every three to six months until three years of age.
- Infants who are not identified with hearing loss, but who have one or more risk factors, should be evaluated at least once before 24-30 months of age. For infants over six months of age, a behavioral audiologic evaluation may suffice if reliable ear-specific information is obtained.

Other referrals may include: Hands & Voices™ Guide-By-Your-Side program (a parent support program), genetics, neurology, ophthalmology, developmental pediatrics, speech-language pathologists, and other professionals.

#### **Sharing Diagnostic Results with Families**

1. Recognize the emotional impact that a diagnosis of hearing loss can have on a family. Audiologists should give the family information about the degree of hearing loss, its potential

impact on speech and language development, the treatment and intervention options available, as well as the positive impacts of early identification.

2. Deliver information and test findings in a positive manner, with sensitivity to the emotional needs of the parents.
3. The information format should be consistent with the family's needs and desires, language and cultural needs, and their ability to interpret the information. Audiologists should give families information that addresses, but is not limited to, the following subject areas related to educating parents and families about hearing loss and its impacts:
  - a. The FRC's role, scope of responsibility, and how to access these services.
  - b. How to access parent/family support groups, and support networks in the deaf/hard-of-hearing communities. The Washington State Hearing Loss Helper is a guide for families of children with hearing loss: [www.doh.wa.gov/Portals/1/Documents/Pubs/344-017\\_EHDDIResourceGuideEng.pdf](http://www.doh.wa.gov/Portals/1/Documents/Pubs/344-017_EHDDIResourceGuideEng.pdf).
  - c. Future diagnostic follow-up and referral to early intervention services.
4. If the family wants to use FRC services, get the parents' permission to contact the FRC to facilitate follow-up.
5. Recognizing that families may not be ready to absorb all of the information in the initial diagnostic evaluation, the audiologist should arrange further discussions with the family, appropriate to their needs and desires. These follow-up discussions may include additional counseling visits, telephone conversations, or counseling coordinated with future clinic visits.

## **Reporting to DOH**

Report diagnostic information to the Department of Health (DOH) after each evaluation until you determine whether or not the infant has a permanent hearing loss. If a hearing loss is present, report each evaluation until the type and degree of hearing loss has been diagnosed. Report this information to DOH by using the EHDDI Program's secure Web-based application or by faxing the results to the EHDDI Program using the "EHDDI Diagnostic Evaluation Form." Please do not send printouts of test results without interpretive information.

The diagnostic information reported should include (but is not limited to) the following:

- Patient information (patient name, date of birth, mother's name)
- Date of evaluation
- Name of audiologist performing the evaluation
- Risk factors associated with hearing loss present
- Results of test(s) performed (ex: immittance, OAE, ABR)
- Hearing loss present – yes, no, or undetermined
- If hearing loss is present, the type and degree of hearing loss
- Referrals (ex: further evaluation, ENT, family resources coordinator)

## Appendix A

Risk indicators associated with permanent congenital, developmental or progressive hearing loss in children (<http://jcih.org/>, 2007 Position Statement):

(1) Parental or caregiver concern regarding hearing, speech, language, and/or developmental delay, (2) family history of permanent childhood hearing loss, (3) neonatal intensive care of more than five days or any of the following regardless of length of stay: ECMO, assisted ventilation, exposure to ototoxic medications (gentamicin and tobramycin) or loop diuretics (furosemide/Lasix), and hyperbilirubinemia that requires exchange transfusion, (4) in-utero infections with cytomegalovirus, herpes, toxoplasmosis, rubella or syphilis, (5) craniofacial anomalies, including those that involve the pinna, ear canal, ear tags, ear pits, and temporal bone anomalies, (6) physical findings, such as white forelock, that are associated with a syndrome known to include a sensorineural or permanent conductive hearing loss (7) syndromes associated with hearing loss or progressive or late-onset hearing loss, such as neurofibromatosis, osteopetrosis, and Usher syndrome; other frequently identified syndromes include Waardenburg, Alport, Pendred, and Jervell and Lange-Nielson (8) neurodegenerative disorders, such as Hunter syndrome, or sensory motor neuropathies, such as Friedreich ataxia and Charcot-Marie-Tooth syndrome (9) culture-positive postnatal infections associated with sensorineural hearing loss, including confirmed bacterial and viral (especially herpes viruses and varicella) meningitis, (10) head trauma, especially basal skull/temporal bone fracture that requires hospitalization, (11) chemotherapy.

## Appendix B

ABR Protocol for 0-6 month old infants, page 1

Re: dB nHL: dB above behavioral threshold for given stimulus (or 0 dB nHL)

dB eHL: Estimated behavioral thresholds taking all correction factors and adjustments into consideration.

### 1. Pediatric Threshold Estimation

Parameters		Notes
Stimulus	<b>2000 Hz toneburst</b>	
Transducer	Insert	
Polarity	Variable	Some authors recommend alternating; others recommend rarefaction
Ramping	Blackman	
Duration	2-0-2	1 msec rise/fall and 0 msec plateau
Intensity	≤40 dB nHL to begin	20-25 dB nHL is WNL. Replicate at threshold. Correction for dB eHL= -5
Filter Settings	30 Hz; 1500 Hz or 3000 Hz	high-pass; low-pass; NO notch
Time window	25 msec	
Stimulus Rate	21.1-39.1/sec	

Stimulus	<b>500 Hz toneburst</b>	
Transducer	Insert	
Polarity	Alternating	To reduce periodic waves
Ramping	Blackman	
Duration	2-0-2	4 msec rise/fall and 0 msec plateau
Intensity	≤50 dB nHL to begin	30-35 dB nHL is WNL. Replicate at threshold. Correction for dB eHL= -15
Filter setting	30 Hz; 1500 Hz or 3000 Hz	high-pass; low-pass; NO notch
Time window	25 msec	
Stimulus Rate	21.1-39.1/sec	

Stimulus	<b>4000 Hz toneburst</b>	
Transducer	Insert	
Polarity	Variable	Some authors recommend alternating; others recommend rarefaction
Ramping	Blackman	
Duration	2-0-2	.5 msec rise/fall and 0 msec plateau
Intensity	≤40 dB nHL to begin	20 dB nHL is WNL. Replicate at threshold. No correction needed for dB eHL.
Filter	30 Hz; 1500 Hz or 3000 Hz	high-pass; low-pass; NO notch

Settings		
Time window	25 msec	
Stimulus Rate	21.1-39.1/sec	

Stimulus	<b>1000 Hz toneburst</b>	
Transducer	Insert	
Polarity	Alternating/variable	To reduce periodic waves
Ramping	Blackman	
Duration	2-0-2	2 msec rise/fall and 0 msec plateau
Intensity	≤40 dB nHL to begin	20-30 dB nHL is WNL. Replicate at threshold. Correction for dB eHL= -10.
Filter Settings	30 Hz; 1500 Hz or 3000 Hz	high-pass; low-pass; NO notch
Time window	25 msec	
Stimulus Rate	21.1-39.1/sec	

ABR Protocol for 0-6 month old infants, page 2

**Threshold Estimation, cont.**

Parameters		Notes
Stimulus	<b>Click</b>	
Transducer	Insert	
Polarity	Rarefaction Condensation (if needed to enhance wave V)	Rarefaction provides larger amplitude and shorter latency than condensation. Replicate at threshold.
Duration	.1 msec	
Intensity	Variable	20 dB nHL is WNL; no correction needed for dB eHL.
Time window	15 msec	
Rate	21.1-39.1/sec	Slower rate if enhanced response is needed
Filter setting	30 Hz; 1500 Hz or 3000 Hz	high-pass; low-pass; NO notch
Sweeps	≥ 600	Enough to adequately overcome SNR and replicate

## 2. Pediatric Neurodiagnostic

Parameters		Notes
Stimulus	<b>Click</b>	
Transducer	Insert	Bone conduction, circumaural headphones only when necessary
Polarity	Condensation & Rarefaction	1 run each to identify wave I vs. stimulus artifact or cochlear microphonic; also 1 run with earphone tube clamped
Duration	.1 ms	
Intensity	$\geq 70$ dB nHL	
Rate	21.1-39.1/sec	Slower rate if enhanced response is needed
Filter setting	30 Hz; 1500 Hz or 3000 Hz	high-pass; low-pass; NO notch
Sweeps	$\geq 400$	Enough to adequately overcome SNR and replicate
Analysis time	15 msec	Pre-stim baseline: -1 msec

## 3. Bone Conduction

Parameters		Notes
Stimulus	<b>Click</b>	Tonebursts as a supplemental measure
Transducer	Bone oscillator that came w/ system (leave inserts in ears after air conduction testing)	Use Velcro or leather headband, or hand-hold
Polarity	Alternating	
Filter Settings	30 Hz; 1500 Hz or 3000 Hz	high-pass; low-pass; NO notch
Duration	.1 ms	
Intensity	$\leq 50$ dB nHL	Identification of Wave I will rule out crossover to non test ear
Time window	15 msec	
Stimulus Rate	21.1-39.1/sec	Reduce rate if poor morphology

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