RISK MONITORING FOR DELAYED-ONSET HEARING LOSS IN YOUNG CHILDREN

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IDAHO ELKS | Hearing and Balance Center

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Did U Check? newborn hearing screening

Disclaimer

- I have no relevant financial relationships with the manufacturers of any commercial products and/or provider of commercial services discussed in this CME activity
- I do not intend to discuss an unapproved/investigative use of a commercial product/device in my presentation

Learning Objectives

- Identify risk indicators which require monitoring for delayed-onset hearing loss
- List risk indicators which require more frequent audiological monitoring
- Explain options for risk monitoring protocols

Joint Committee on Infant Hearing (JCIH)

JCIH was established in 1969

Comprised of:

- **American Academy of Pediatrics**
- **American Academy of Ophthalmology and Otolaryngology**
- **American Speech & Hearing Association**

JCIH position statements

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JCIH 1973 Position Statement

- **High risk criteria**
  - **Family history of childhood hearing loss**
  - **Intrauterine fetal infection (Rubella)**
  - **Defects of ear, nose or throat (atresia, cleft lip/palate)**
  - **Low birth weight (<1500 grams)**
  - **High bilirubin levels**

JCIH 1982 Position Statement

- High risk criteria
  - »Bacterial meningitis, severe asphyxia (i.e. low APGAR) were added
- Screening recommendations
  - »Ideally performed by 3 months (no later than 6 months)
  - »Preferably under the supervision of an audiologist
  - »Observation of behavioral or electrophysiologic response to sound

JCIH 1990 Position Statement

High risk criteria additions:

- »Ototoxic medications
- »Prolonged mechanical ventilation
- »Physical findings of syndromes
- »Parent/caregiver concerns
- »Head trauma
- »Neurodegenerative disorders
- »Infectious diseases associated with hearing loss

Screening recommendation changes:

- »Auditory Brainstem Response measurement, not behavioral testing

JCIH 1994 Position Statement

Studies showed that only 50% of all hearing loss were being identified using the High Risk Register

- Pappas, 1983
- Elssman, Matkin, Sabo 1987
- Mauk, white, mortensen, Behrens 1991

JCIH 2000 Position Statement

Risk monitoring:

- **Audiological testing every 6 months until age 3 years.**

Joint Committee on Infant Hearing (JCIH)

YEAR 2007 POSITION STATEMENT: Principles and Guidelines for Early Hearing Detection and Intervention Programs

JCIH 2007 Position Statement

- **Expanded definition of targeted hearing loss to include:**
  - **Neural hearing loss (Auditory Neuropathy/Dysynchrony) in infants admitted to the NICU**

- **Separate protocols for NICU and well baby nurseries:**
  - **NICU babies (>5 days) are to have ABR screening so that neural hearing loss will not be missed**

JCIH 2007 Position Statement

- **Re-admissions**
  - **Infant readmitted in the first month of life and present with conditions, which are associated with potential hearing loss, need a repeat hearing screen prior to discharge.**

- **Monitoring of high risk indicators**
  - **"Infants with risk factors for hearing loss should have at least one diagnostic evaluation by 24-30 months of age."**

JCIH 2007
Appendix 2: RISK INDICATORS FOR HEARING LOSS

- ☐ Caregiver concerns (re: hearing, speech, language, or developmental delay)
- ☐ Family history of permanent childhood hearing loss
- ☐ Neonatal Intensive Care (NICU) of more than 5 days or any of the following regardless of length of stay: ECMO, assisted ventilation, exposure to ototoxic medications (gentimycin and tobramycin) or loop diuretics (furosemide, Lasix), and hyperbilirubinemia that requires exchange transfusion.
- ☐ In-utero infections
- ☐ Craniofacial anomalies
- ☐ Known physical findings associated with a syndrome
- ☐ Syndromes associated with hearing loss, progressive hearing loss or late-onset hearing loss neurodegenerative disorders
- ☐ Culture-positive postnatal infections associated with hearing loss
- ☐ Head trauma, especially basal skull/temporal bone, requiring hospitalization
- ☐ Chemotherapy

Risk indicators for delayed-onset hearing loss

Incidence of risk factors for hearing loss

- Epstein and Reilly (1989) reported 10-12% of all babies had at least one risk factor

Most frequently occurring risk factors	Least frequently occurring risk factors (<10%)
Ototoxic Medications (>70%)	Hyperbilirubinemia
Severe Asphyxia (>50%)	Craniofacial anomalies
Mechanical Ventilation less than 5 days (>25%)	Family history
Low birth weight (>20%)	Congenital infections
Parental/Physician concerns (>15%)	Bacterial meningitis
ECMO (>10%)	Substance abuse (maternal)
	Neurodegenerative disorders

(Cone-Wesson, et al., 2000; Van Riper & Kileny, 1999; Van Riper & Kileny, 2002; Hall, 2007)

Frequency of hearing loss among high risk indicators

Craniofacial anomalies (>50%)
ECMO treatments (>20%)
Severe Asphyxia/ Mechanical ventilation (>15%)
Congenital infections (>15%)
Family History (>15%)
Bacterial meningitis (>10%)
Other risk indicators (<10%)

(Cone-Wesson, et al., 2000; Van Riper & Kileny, 2002; Hall, 2007; Fligor, 2008)

Ototoxic Medications

- **Over 200 known ototoxic medications (prescriptions and OTC)**
- **Used to treat serious infections, cancer, heart disease**
- **Damage may be temporary or permanent**
  - **Aspirin (temporary)**
  - **Cisplatin (permanent)**

Aminoglycosides

- Introduced in 1940s
- Used to treat serious infections due to multi-drug resistant Gram negative bacteria
- May remain in hair cells for months after application (Aran et al, 1999)
- "…weekly or biweekly monitoring is recommended ideally." "…follow-up testing should also be scheduled a few months after drug discontinuation." (AAA Ototoxicity Monitoring, 2009)

Gentamicin

- Introduced 1963
- Most common aminoglycoside used in NICU
- Low cost
- Effectiveness against most Gram-negative bacteria

ASHA 2010- Evidence Based Systematic Review: Drug-Induced Hearing Loss- Gentamicin

- Systematic literature review (20 studies)
- Reported hearing loss from gentamicin induced cochleototoxicity ranging from 0-58%
- Studies varied in dosing, patient populations, diagnostic testing, diagnostic criteria for hearing loss

ASHA 2010- Evidence Based Systematic Review: Drug-Induced Hearing Loss- Gentamicin

- **Trends noted in the studies:**
  - **Frequency of administration did not influence the likelihood of hearing loss**
  - **Dosing amount did not influence the likelihood of hearing loss**

A1555G genetic mutation

- **Prezant et al (1993) reported on the genetic mutation A1555G, associated with aminoglycoside deafness**

- **Estivill et al (1998) reported profound hearing loss without aminoglycoside treatments**

A1555G genetic mutation

- United Kingdom study (2002) found 1 in 206 newborns expressing the mutation
- Texas study (1999) only 1 in 1,161 newborn with mutation

Ototoxicity in preterm infants (Zimmerman E, Lahav A, 2012)

- **Effects of genetics**
  - **Iowa Children's Hospital (Ealy et al 2011)**
  - **N=703 (1.8% with mtDNA variant)**
  - **No hearing loss**
- **Loud noise exposure**
  - **Animal studies have found potentiating effect between noise and aminoglycosides**

Neonatal Intensive Care (NICU)

National Perinatal Research Center (NPIC) (Quality Analytic Services (QAS)

- **Approximately 25% of NICU infants are considered "LOW" risk and discharged by 5 days old.**
- **The remaining approximately 75% of NICU infants, who are hospitalized for greater than 5 days, are considered the "TARGET" population to rule out neural hearing loss.**

****NICU stay of greater than 5 days and exposure to loop diuretics were not associated with increased risk of hearing loss (Kraft et al, 2014)**

Mechanical Ventilation/Hypoxia

Cone-Wesson et al. (2000) estimates 1/56 children with permanent hearing loss at age 1

Robertson et al. (2002) found greater than 50% of severe neonatal respiratory survivors had sensorineural hearing loss at 4 years old

Beswick et al (2013) study found a correlation between postnatal hearing loss and prolonged ventilation (≥5 days)

Expracorporeal Membrane Oxygenation (ECMO)

- **Expracorporeal Membrane Oxygenation (ECMO)- is an aggressive treatment that is used for the life support in infants with respiratory or cardiopulmonary failure**

ECMO (Fligor, 2008)

- N = 111 neonates
- Congenital Diaphragmatic Hernia raised risk of SNHL 2.6 times
- Aminoglycoside antibiotics cumulative of 14 days or more in the course of ECMO raised the risk of SNHL by 5.56 times
- ECMO 160 hours raised risk of SNHL 7.18 times

Physical findings/Syndromes associated with hearing loss

- Waardenburg syndrome
- Branchio-Oto-Renal (BOR) syndrome
- Stickler syndrome
- CHARGE syndrome
- NeurofibromatosisType II
- Downs syndrome
- Treacher Collins syndrome
- Usher syndrome
- Pendred syndrome
- Alport syndrome
- Jervell Lange-Nielsen

Infections

Congenital Infections

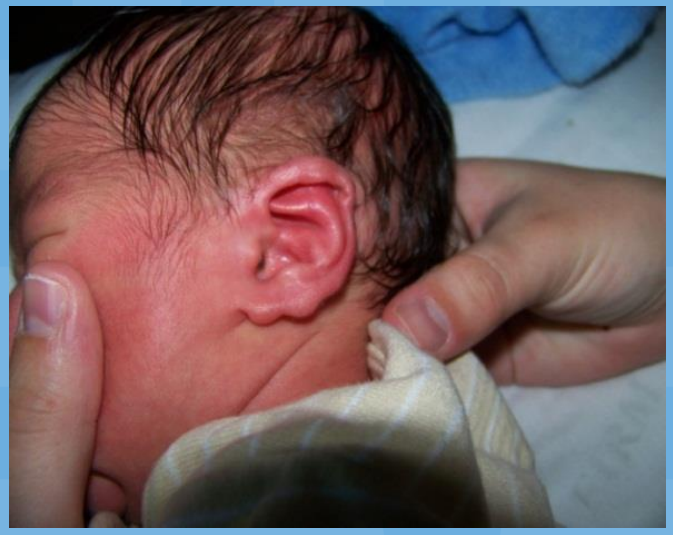
- Cytomegalovirus (CMV)
- Rubella
- Herpes
- Syphilis
- Toxoplasmosis

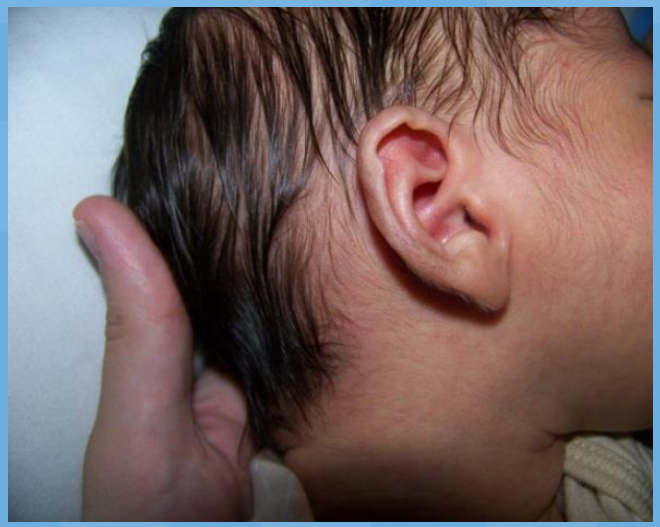
Postnatal infections

- Bacterial or viral meningitis
- Varicella
- Herpes viruses

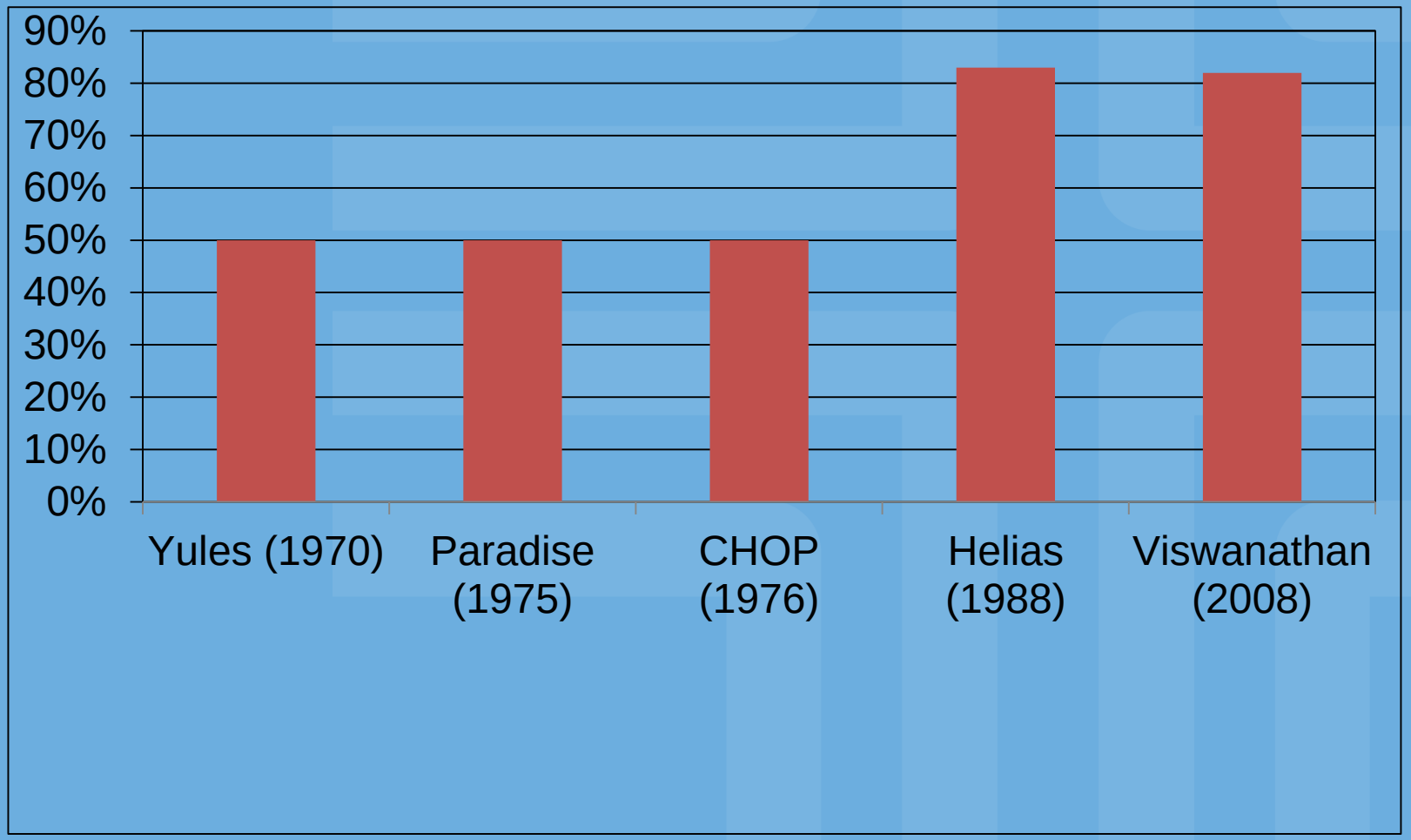
Craniofacial anomalies

- Head trauma
- Recurrent OME
- Cleft palate
- Abnormal pinna
- Abnormal ear canal
- Ear tags and pits
- Malformed eyes
- Choanal atresia
- Craniosynostosis
- Hemifacial microsomia

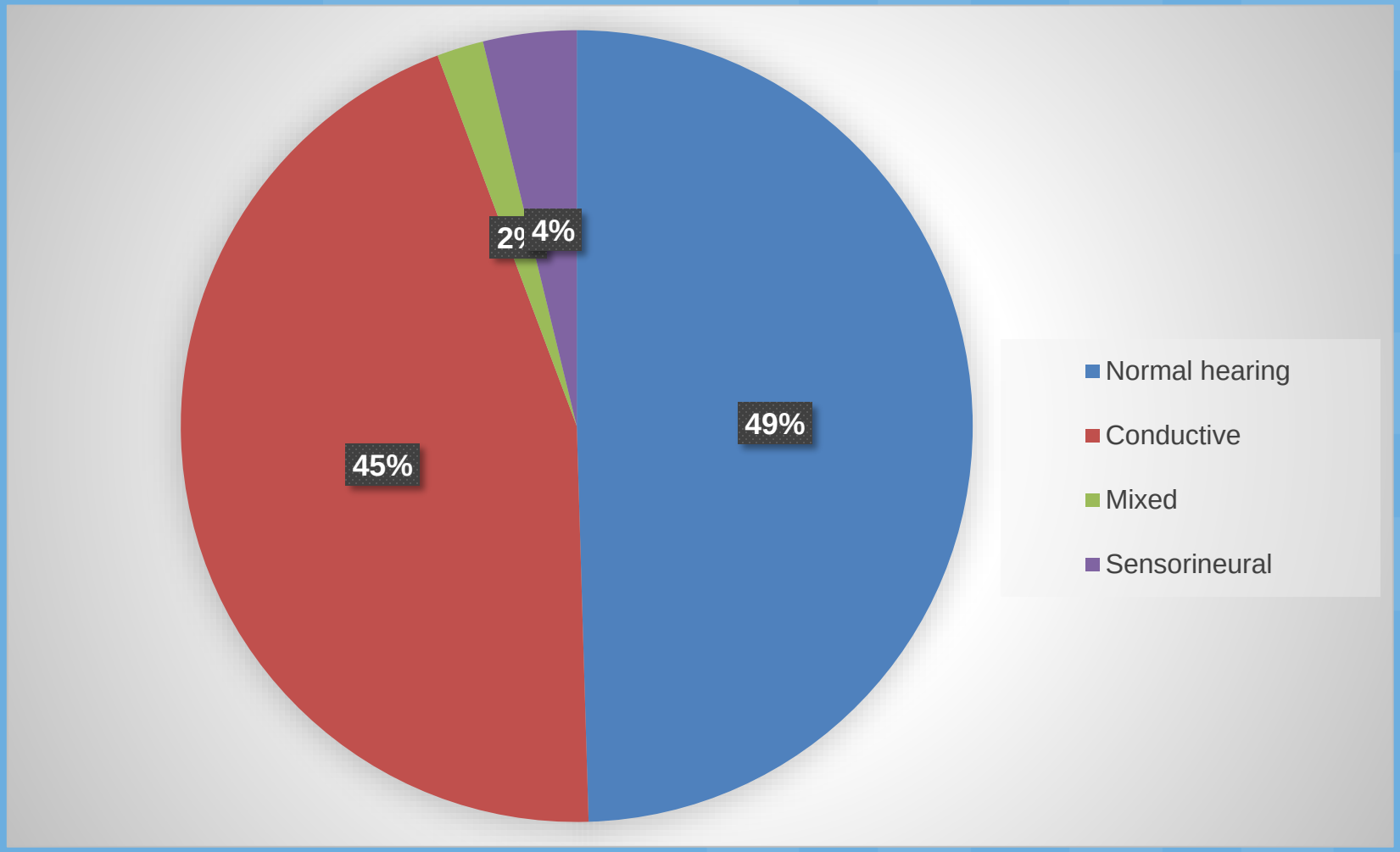




% of hearing loss in cleft palate patients



Idaho Cleft Palate and Craniofacial Deformities team (Oct 2007- Feb 2010)



Family History

- Positive family history of congenital hearing loss or hearing loss acquired during childhood
- Family history of hearing loss is the most common risk indicator found in healthy newborns (Hall 2007)
- Australia study (Beswick, et al. 2013) showed that the risk factor of family history did predict the occurrence of postnatal hearing loss

Head trauma

- Involving basal skull/temporal fracture that requires hospitalization

- May result in:
  - Facial nerve paralysis (partial, complete)
  - Hearing loss (conductive, sensorineural, mixed)
  - Vertigo
  - Tympanic membrane perforations

Neurodegenerative disorders/Sensory motor neuropathies

- Hunter syndrome
- Charcot Marie Tooth disease
- Friedreich ataxia

Recent publications looking at risk indicators for delayed-onset hearing loss

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Beswick et al (2012)

- Literature Review (40 articles)
- CMV, ECMO, congenital diaphragmatic hernia, persistent pulmonary hypertension associated with postnatal hearing loss

Beswick et al (2013)

- N = 2107 children
- 2.7% with postnatal hearing loss
- Findings:
  - Family history and craniofacial anomalies (monitored throughout childhood)
  - Syndromes and prolonged ventilation (favorable results for monitoring)
  - Low Birth Weight (no monitoring)

Kraft et al (2014)

- Prospective study
- Evaluate risk indicators for childhood hearing loss
- Estimate cost burden of monitoring imposed by some risk indicators
- Findings: NICU stay and exposure to loop diuretics are not associated with increased risk for delayed onset hearing loss

Vos et al (2015)

- Literature review
- Findings
  - Family History of HL, consanguinity in (grand)parents, malformation syndromes, fetal alcohol syndrome (HIGH)
  - Hyperbilirubinemia (MODERATE)
  - Low birth weight, low APGAR, NICU stay, ototoxic medications (LOW/VERY LOW)

Risk monitoring programs

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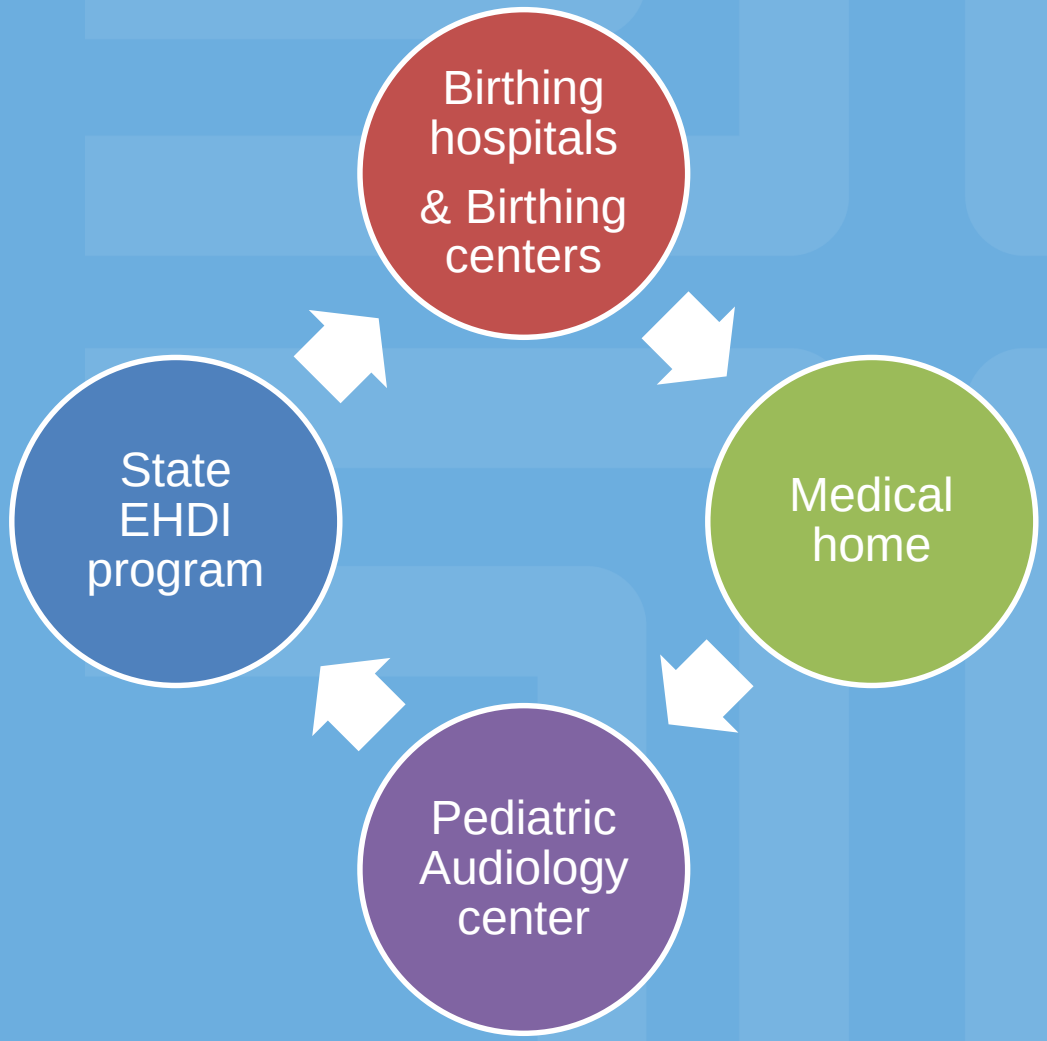
Goals of risk monitoring programs

- Identify infants and children at risk for delayed onset or progressive hearing loss
- Timely diagnostic assessments from a pediatric audiologist
- Maintain a monitoring and tracking system in the state EHDI data management system

EHDI Risk Monitoring Programs



Hospitals/Birthing Center roles:

- Identify infants who have 1 or more risk indicators
- Provide family with referral to pediatric audiology clinic
- Provide family with information about risk indicators
- Provide medical home information regarding risk indicator referral
- Report infants with risk indicators to state EHDI program

Script for hearing screeners

"Your baby has been identified as having a risk indicator for (_____) for delayed-onset hearing loss. The recommendation for babies with risk indicators is an audiological evaluation around 9 months of age. You will receive a reminder letter when your baby is 8 months old along with a list of pediatric audiologists who can test infants and toddlers."

Medical home roles:

- Being familiar with risk factors for delayed onset hearing loss
- Explaining screening results and answer questions for the family
- Encourage risk monitoring follow-up
- Providing family with referral to pediatric audiology clinic

Pediatric audiology center roles:

- Providing appropriate comprehensive diagnostic testing for children with risk factors
- Knowledge of risk factors that have high prevalence of delayed onset hearing loss and require early and more frequent assessments
- Providing documentation regarding evaluation outcomes to state EHDI program

State EHDI program roles:

- Providing training and support for hospitals, birthing center, physicians, and pediatric audiologists on risk factor
- Providing a method for hospitals, birthing centers and pediatric audiologists to report information regarding infants with risk indicators to the state EHDI program
- Tracking and surveillance of infants with risk factors

Idaho EHDI program

Data collected by referral forms

IDAHO SOUND BEGINNINGS (ISB)
Early Hearing Detection and Intervention
Department of Health and Welfare, Infant Toddler Program

FAX TO (208) 332-7331
Within 5 days

Newborn Hearing Screening Referral Form

Complete Form for *All*: Refers ☐ Risks ☐ Transfers* ☐ Missed ☐ or Incomplete ☐

Birth Hospital: _____

(*Transfers only) Receiving Hospital: _____ [Please Press Firmly]

Within 5 days of screening or discharge— Distribute copies to: Audiologist - White; ISB - Gold; Hospital - Pink; Parent - Green; Physician - Yellow

Send to: Idaho Sound Beginnings-EHDI , PO Box 83720, Boise, ID 83720-9615 or Fax: (208) 332-7331

1. BABY'S INFORMATION:

Baby's Med Record #: _____

Baby's Name: _____ (Last, First)

DOB: ____/____/____ Gender: ☐ M ☐ F

Nursery: ☐ Well Baby ☐ NICU/Special Care

Baby's Primary Physician/Clinic: _____

Mother's name: _____

2. CONTACT INFORMATION:

Parent/Guardian: _____ (Last, First)

Address: _____

City: _____ State: ____ Zip: _____

Main Phone: _____ Text? _____

Alternate Phone/Contact: _____

Email/other contact: _____

3. HEARING SCREEN RESULTS:

First Screen: R ☐ Pass ☐ Refer ☐ No Result

_____ (Date) L ☐ Pass ☐ Refer ☐ No Result

Second Screen: R ☐ Pass ☐ Refer ☐ No Result

_____ L ☐ Pass ☐ Refer ☐ No Result

4. RISK ASSESSMENT (check all that apply)

FOR LATER-ONSET CHILDHOOD HEARING LOSS:

___Family History of Permanent Hearing Loss <18 yrs of age

___NICU stay >5 days

___Syndrome Associated with HL (e.g. Downs)

___Congenital Infection (e.g. T-O-R-C-H)

___Postnatal Infection (e.g. Meningitis)

___Craniofacial Anomalies- _____

___Ototoxic Medications - any amount

___Mechanical Ventilation - any amount

___Parent or Physician Concern

___Head Trauma ___ Other _____

(monitoring through age 3 is recommended for most risk factors)

Nursing/screening staff will inform you of the final results of the baby's hearing screen and give you a copy of these results. If your baby needs testing or follow-up for risks, you will be given an appointment and/or follow-up information. If you have questions please contact Idaho's Early Hearing Program, Idaho Sound Beginnings, at (208) 334-5828. Financial Assistance for diagnostic testing may be available.

☐ Your baby did not pass the hearing screen. Hearing testing should be completed before baby is 3 months old. If baby is not hearing all the sounds necessary for speech and language development early identification can minimize any communication delays.

☐ Your baby is at risk for later-onset childhood hearing loss. Hearing testing at approximately 9 months of age is recommended for most risk factors. A Pediatric Audiologist can advise on the appropriate monitoring schedule for your baby.

Audiologist: _____

Phone: _____

Address: _____

Appt. date/time: _____

I have been informed of my baby's hearing screen results and of the need for diagnostic audiology (hearing) testing before the age of 3 months (if baby did not pass) to determine if a hearing loss is present. If baby passed the hearing screen, but risk factors are present (see above), hearing testing is recommended at approximately 9 months of age. (American Academy of Pediatrics (AAP) Guidelines)

I hereby give permission to the staff of the above-named hospital/screening site to release medical information necessary to complete an audiology evaluation for my child to the listed audiologist/clinic (or the audiologist of my choice) and physician. I also give permission to the hospital and audiologist/clinic, and Idaho Sound Beginnings to share the results of the hearing screening and diagnostic audiology evaluations with the above-named physician, the Idaho Infant-Toddler Program, Idaho School for the Deaf and Blind, and Idaho Hands & Voices. I understand that the information will only be used to ensure that appropriate and timely medical, educational, and audiologic services are made available to my child.

Hearing screening results are reported to Idaho Sound Beginnings –Idaho's Early Hearing Detection & Intervention Program and are not shared with the above listed entities or any other outside entities without parent/guardian consent.

I have had the opportunity to read this clinic's Notice of Privacy Practices. I understand that this information will not be shared with unauthorized individuals. This authorization expires 36 months from the date signed.

Parent/Guardian: _____ Date: _____

8/2012

4. RISK ASSESSMENT (check all that apply)

FOR LATER-ONSET CHILDHOOD HEARING LOSS:

___Family History of Permanent Hearing Loss <18 yrs of age

___NICU stay >5 days

___Syndrome Associated with HL (e.g. Downs)

___Congenital Infection (e.g. T-O-R-C-H)

___Postnatal Infection (e.g. Meningitis)

___Craniofacial Anomalies- _____

___Ototoxic Medications - any amount

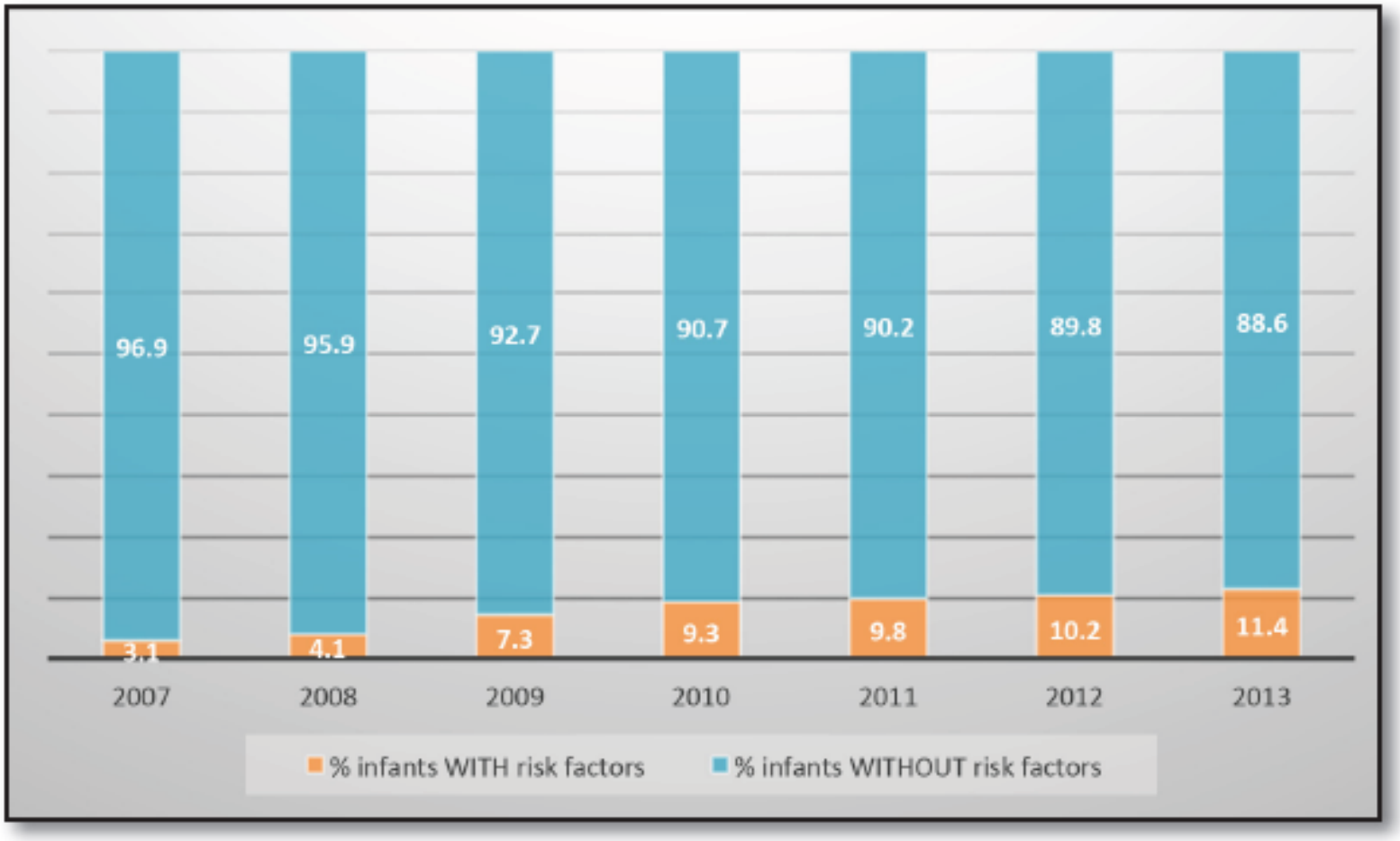
___Mechanical Ventilation - any amount

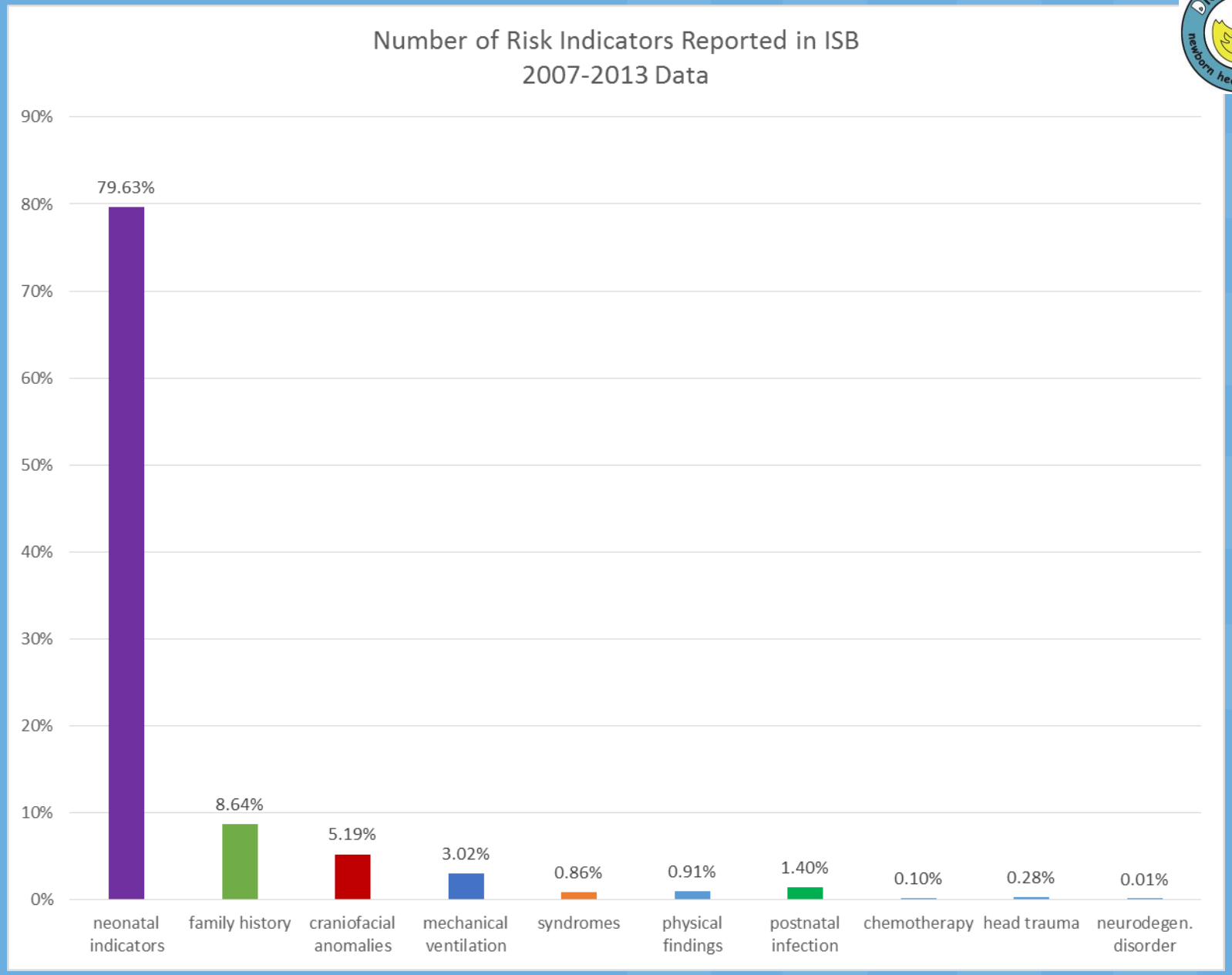
___Parent or Physician Concern

___Head Trauma ___ Other _____

(monitoring through age 3 is recommended for most risk factors)

Prevalence of Infants with a Risk Indicator in ISB 2007-2013 Data





Idaho's classification system for risk monitoring

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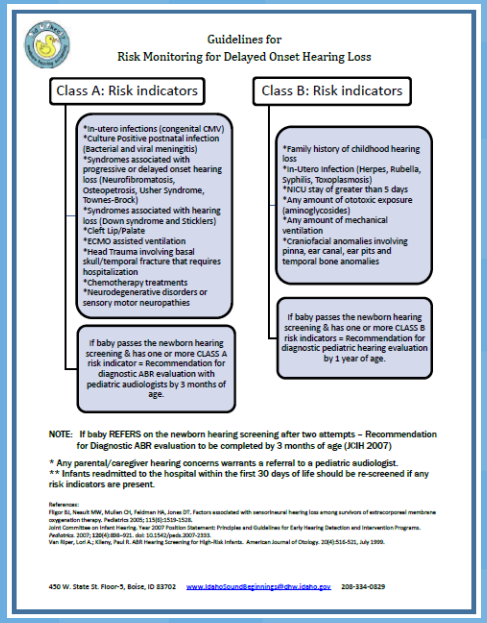
Class A & Class B

- Pediatric audiologist and NICU physicians began discussions
  - May 2011
- Developed guidelines
  - May-October 2011
- Two hospitals implemented
  - October 2011



Guidelines for
Risk Monitoring for Delayed Onset Hearing Loss

Class A: Risk indicators

*In-utero infections (congenital CMV)
*Culture Positive postnatal infection (Bacterial and viral meningitis)
*Syndromes associated with progressive or delayed onset hearing loss (Neurofibromatosis, Osteopetrosis, Usher Syndrome, Townes-Brock)
*Syndromes associated with hearing loss (Down syndrome and Sticklers)
*Cleft Lip/Palate
*ECMO assisted ventilation
*Head Trauma involving basal skull/temporal fracture that requires hospitalization
*Chemotherapy treatments
*Neurodegenerative disorders or sensory motor neuropathies

If baby passes the newborn hearing screening & has one or more CLASS A risk indicator = Recommendation for diagnostic ABR evaluation with pediatric audiologists by 3 months of age.

Class B: Risk indicators

*Family history of childhood hearing loss
*In-Utero infection (Herpes, Rubella, Syphilis, Toxoplasmosis)
*NICU stay of greater than 5 days
*Any amount of ototoxic exposure (aminoglycosides)
*Any amount of mechanical ventilation
*Craniofacial anomalies involving pinna, ear canal, ear pits and temporal bone anomalies

If baby passes the newborn hearing screening & has one or more CLASS B risk indicators = Recommendation for diagnostic pediatric hearing evaluation by 1 year of age.

NOTE: If baby REFERS on the newborn hearing screening after two attempts – Recommendation for Diagnostic ABR evaluation to be completed by 3 months of age (JCIH 2007)

* Any parental/caregiver hearing concerns warrants a referral to a pediatric audiologist.
** Infants readmitted to the hospital within the first 30 days of life should be re-screened if any risk indicators are present.

References:
Pfiger BJ, Nawit MW, Mullen CH, Feldman HA, Jones DT. Factors associated with sensorineural hearing loss among survivors of extracorporeal membrane oxygenation therapy. Pediatrics 2005; 115(6):1519-1526.
Joint Committee on Infant Hearing. Year 2007 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs. Pediatrics. 2007; 120(4):898-921. doi: 10.1542/peds.2007-2333.
Van Riper, Lori A.; Kilieny, Paul F. ABR Hearing Screening for High-Risk Infants. American Journal of Otology. 20(4):516-521, July 1999.

450 W. State St. Floor-5, Boise, ID 83702 www.IdahoSoundBeginnings@dhw.idaho.gov 208-334-0829

Class A: Risk indicators

*In-utero infections (congenital CMV)
*Culture Positive postnatal infection (Bacterial and viral meningitis)
*Syndromes associated with progressive or delayed onset hearing loss (Neurofibromatosis, Osteopetrosis, Usher Syndrome, Townes-Brock)
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*ECMO assisted ventilation
*Head Trauma involving basal skull/temporal fracture that requires hospitalization
*Chemotherapy treatments
*Neurodegenerative disorders or sensory motor neuropathies

If baby passes the newborn hearing screening & has one or more CLASS A risk indicator = Recommendation for diagnostic ABR evaluation with pediatric audiologists by 3 months of age.

Class B: Risk indicators

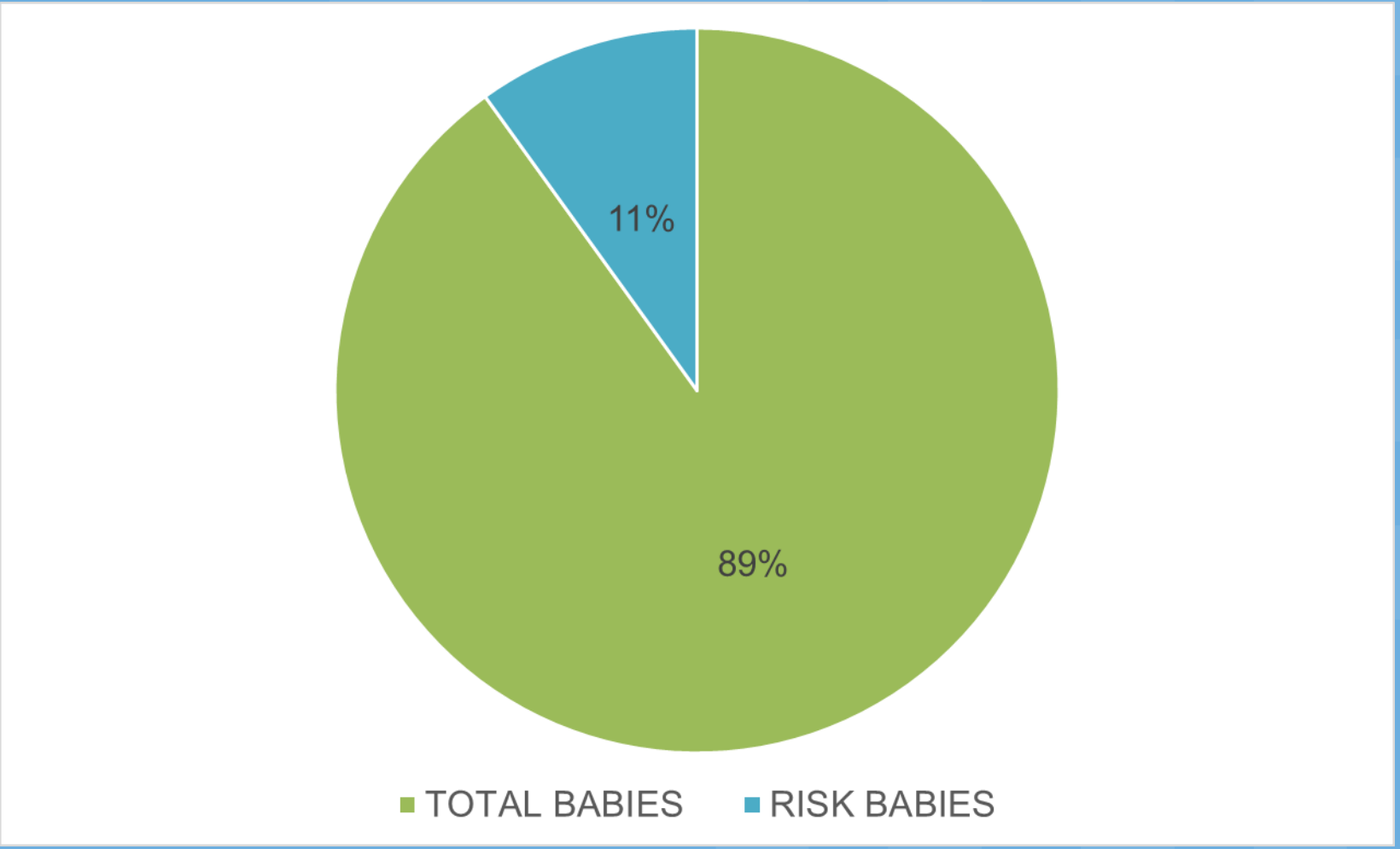
*Family history of childhood hearing loss
*In-Utero Infection (Herpes, Rubella, Syphilis, Toxoplasmosis)
*NICU stay of greater than 5 days
*Any amount of ototoxic exposure (aminoglycosides)
*Any amount of mechanical ventilation
*Craniofacial anomalies involving pinna, ear canal, ear pits and temporal bone anomalies

If baby passes the newborn hearing screening & has one or more CLASS B risk indicators = Recommendation for diagnostic pediatric hearing evaluation by 1 year of age.

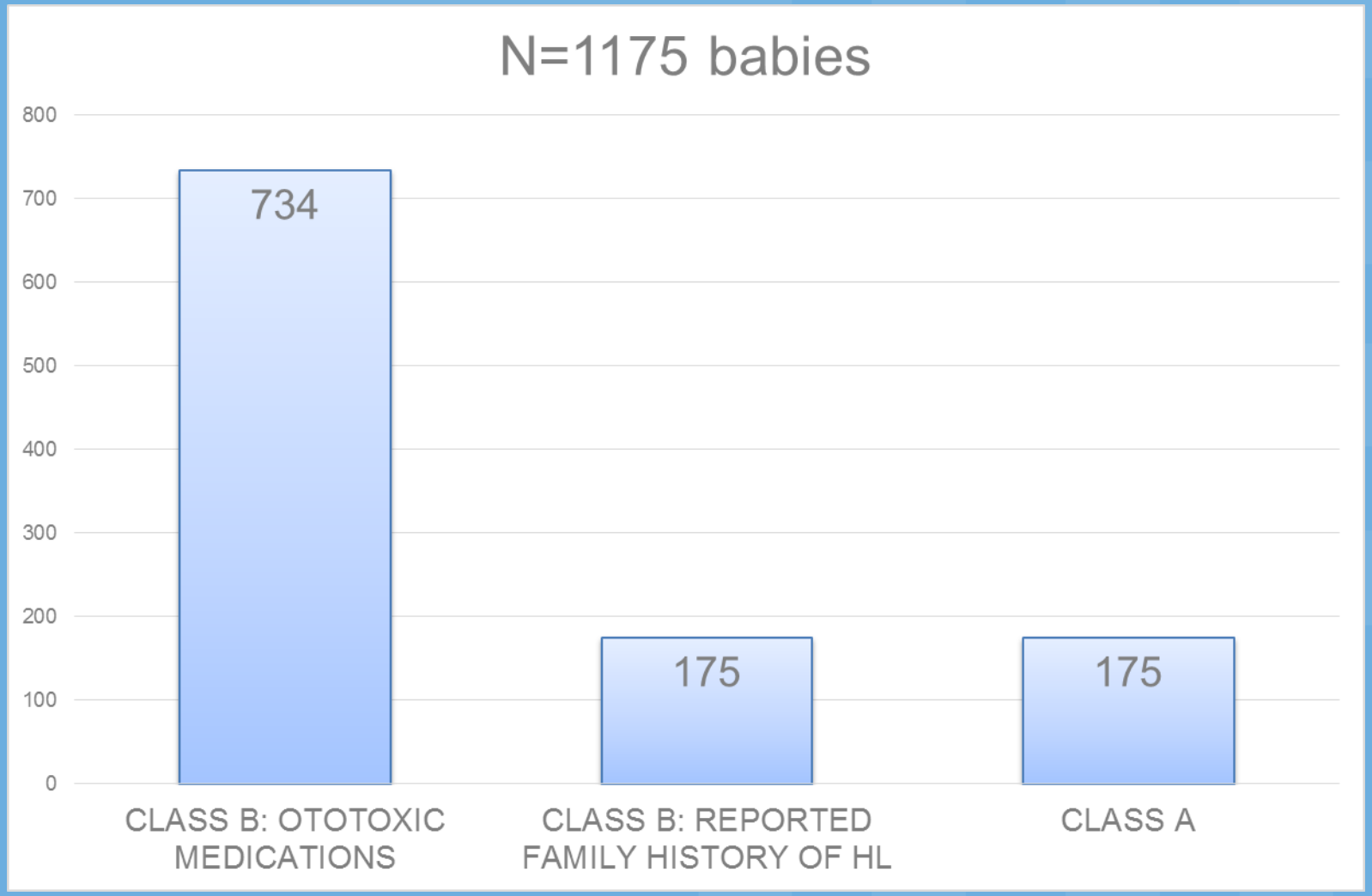
Data collected
January 2012- December 2013

- HiTrack data management system
- Reviewed data November 2015
- N= 10,634 babies
- = 1.6% 175 babies with CLASS A risk indicator
- =11.04% 1175 babies with any risk indicator (CLASS A and/or CLASS B)

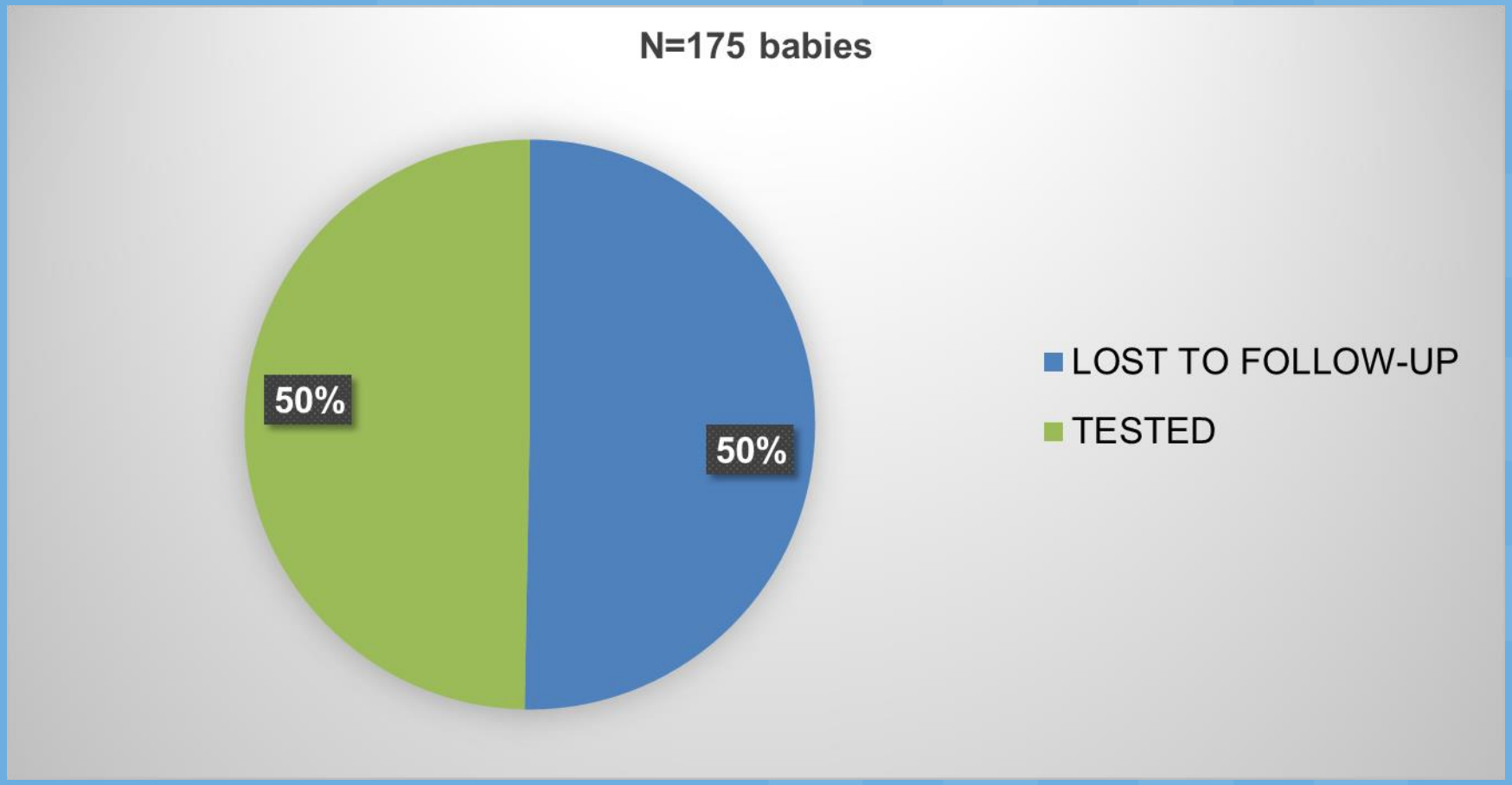
% babies with reported risk indicators (2012-2013)



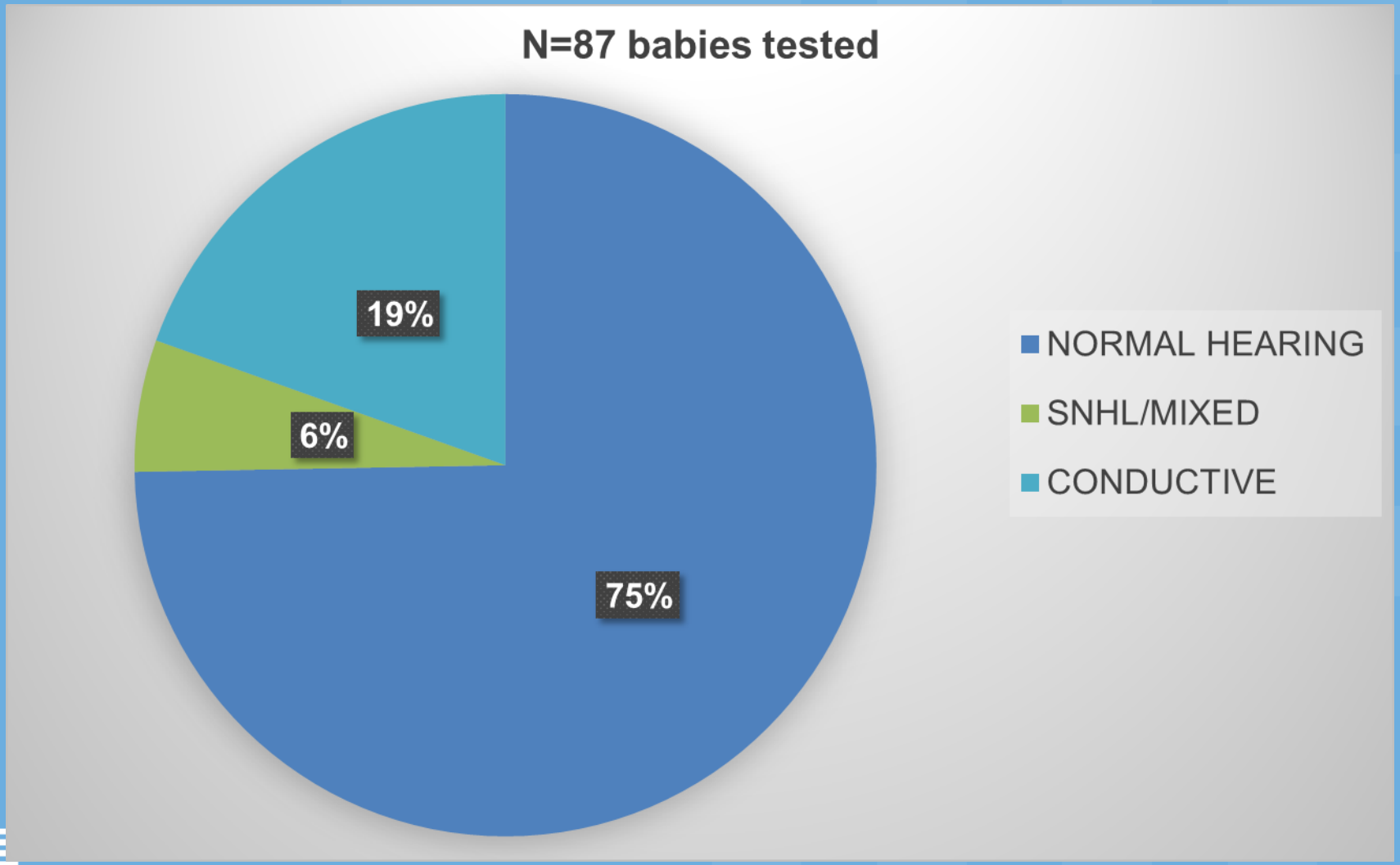
Risk indicator occurrence



Class A risk indicators



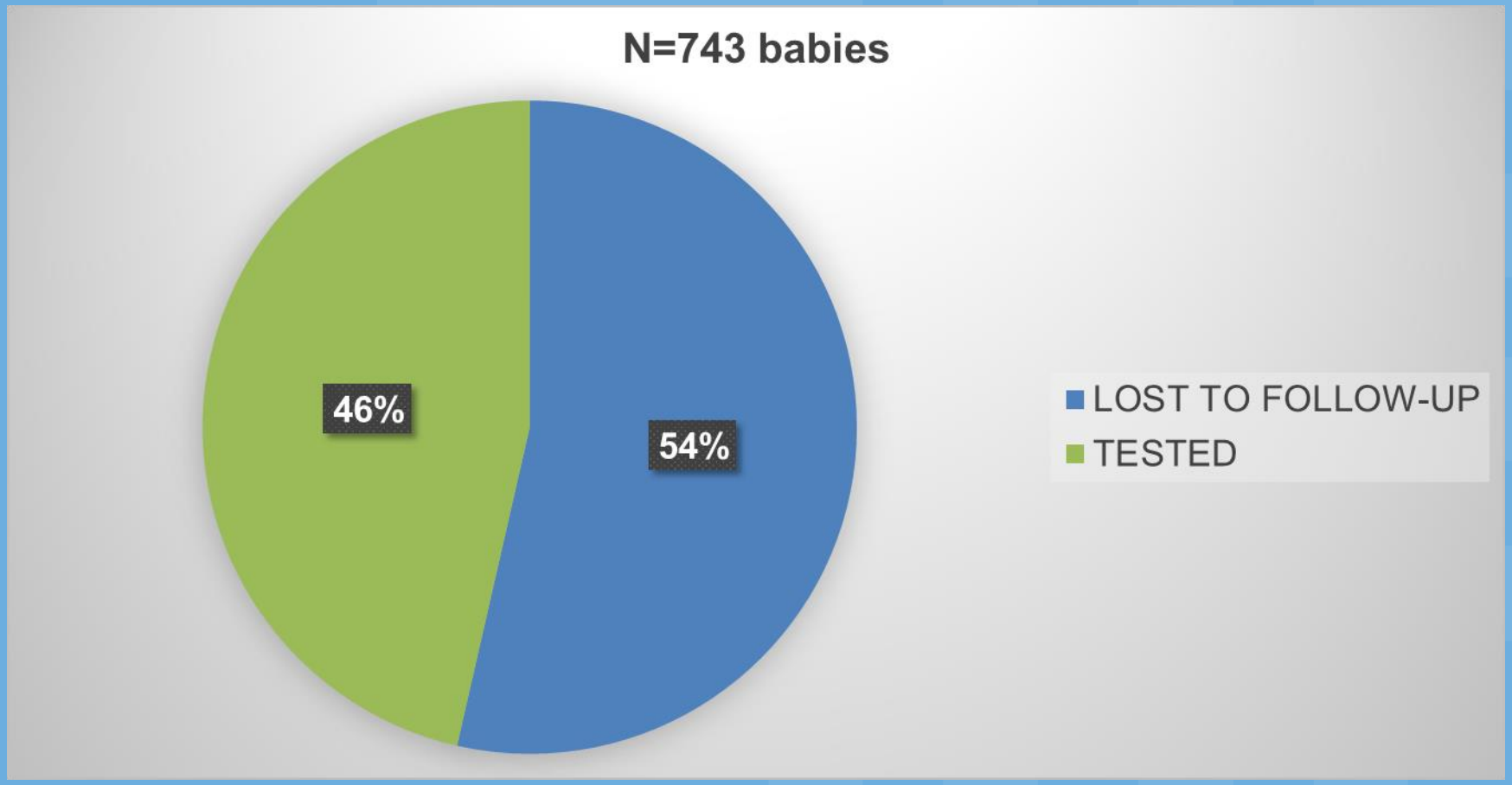
Class A risk indicators



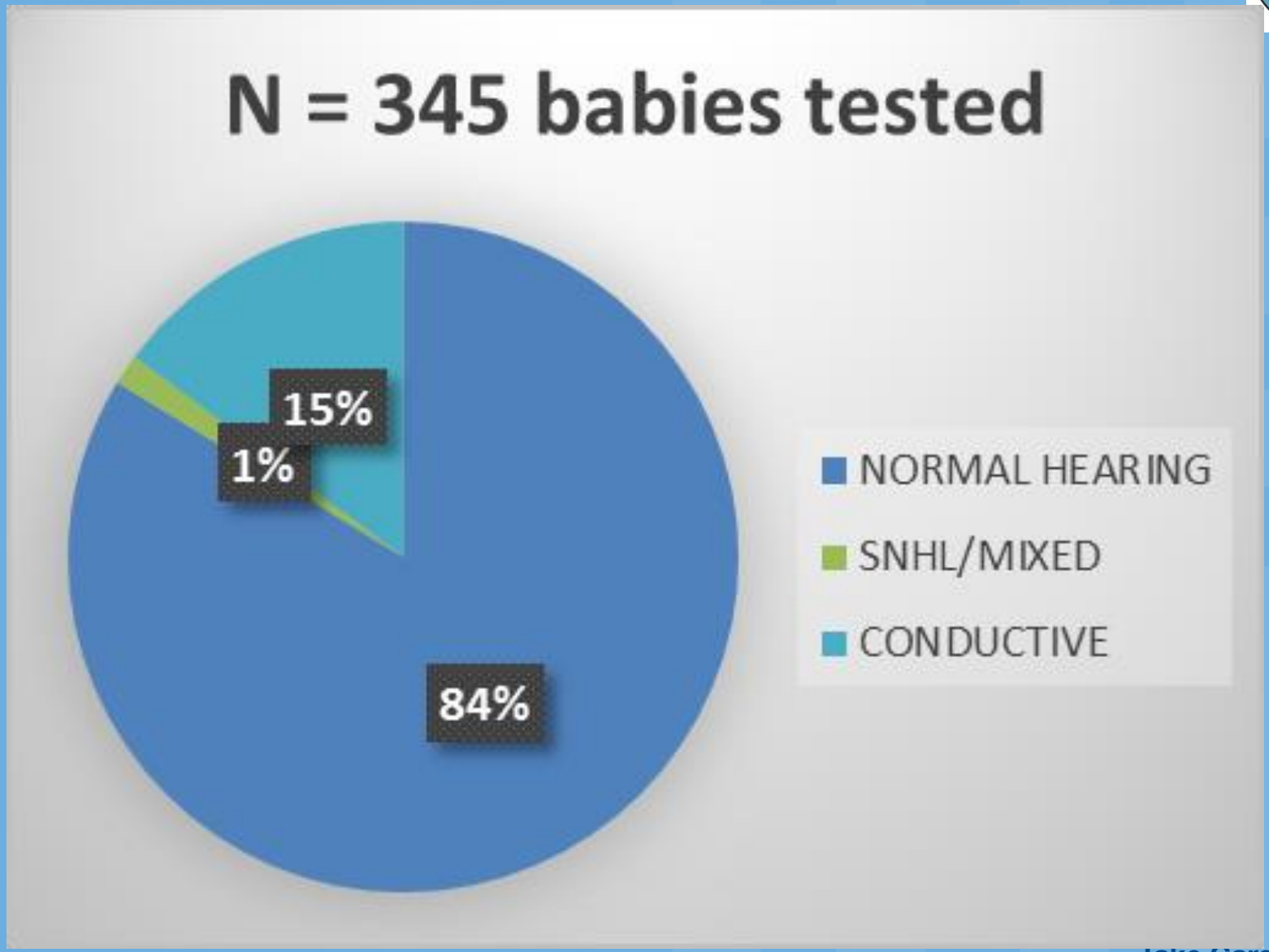
Children with Class A risk indicators & permanent hearing loss

- **5/87 sensorineural/mixed hearing loss**
  - **2 children with cleft palate**
  - **1 child with Townes Brock syndrome**
  - **1 child with Acrofacial Dysostosis**
  - **1 child with congenital CMV**

Class B/Ototoxic Medications



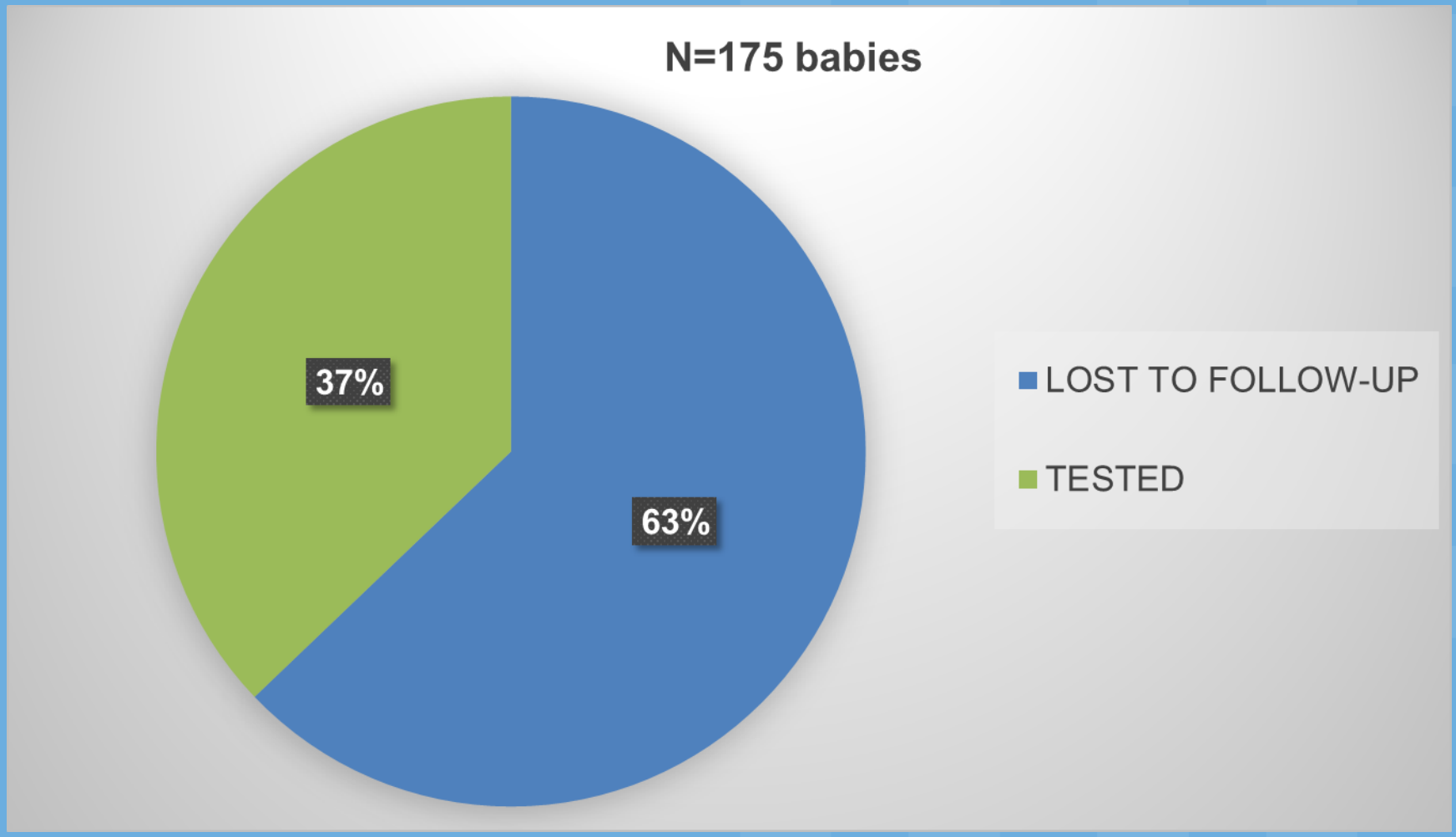
Class B/Ototoxic Medications



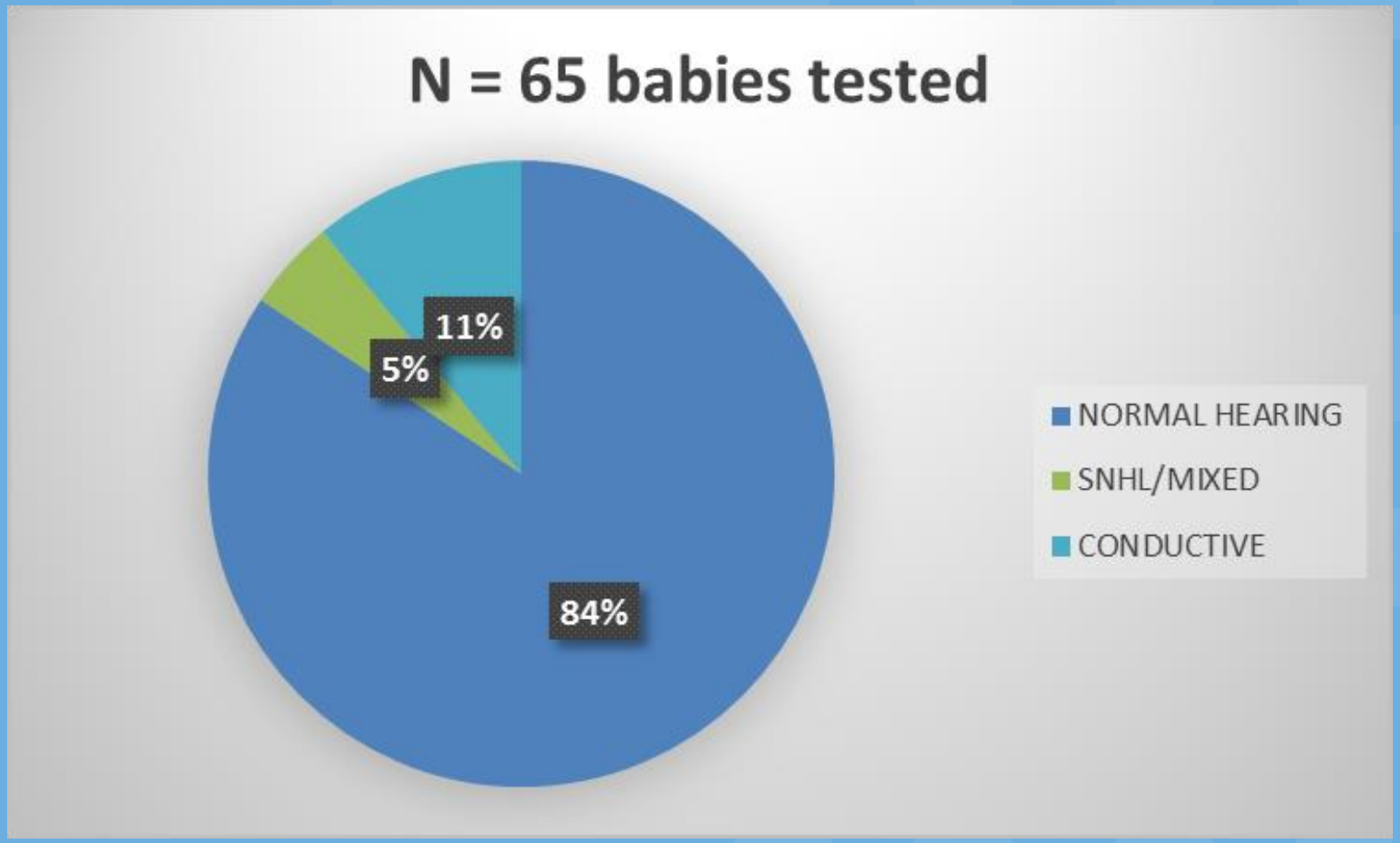
Children with history of Ototoxic medications & permanent hearing loss

- **5/345 children with sensorineural/mixed hearing loss**
  - **1 child with ototoxic medications and extended NICU stay**
  - **1 child with ototoxic medications, mechanical ventilation, extended NICU stay**
  - **3 children ototoxic medication plus CLASS A risk indicator**

Class B/Family History



Class B/Family History



Children with positive family history & permanent hearing loss

- **3/65 sensorineural/mixed hearing loss**
  - **2 children with only risk indicator Family History (siblings)**
  - **1 child with multiple risk indicators (syndrome, family history, ototoxic medications, mechanical ventilation, extended NICU stay)**

Barriers to monitoring risk indicators for delayed-onset hearing loss

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Services provided by St. Luke's

Barriers

- **Accurate reporting by hospital staff**
- **Accurate reporting by families (i.e. family history)**
- **Accurate and timely reporting by audiologists**
- **Shortage of pediatric audiologists**
- **High lost-to follow-up rates**
- **Lack of support by medical homes**
- **No standard protocol for audiological monitoring of risk indicators**
  - What age to start/stop monitoring
  - What tests to use for evaluation

Why do we monitor children with risk indicators for delayed-onset hearing loss…

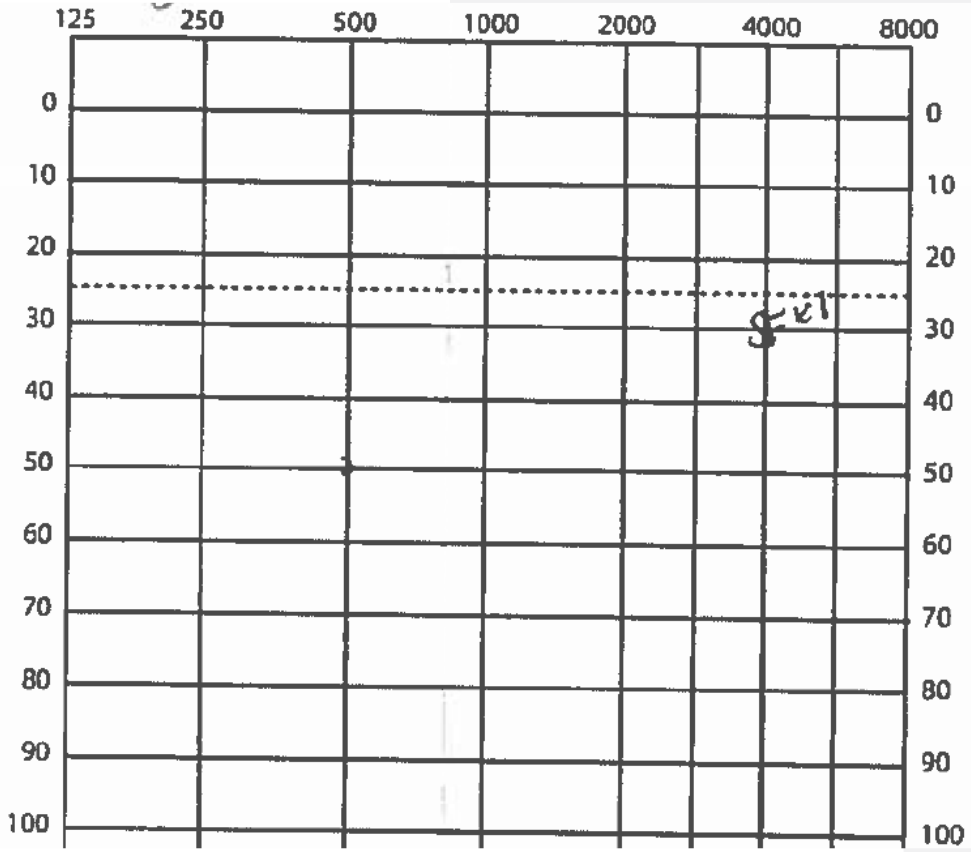
IDAHO ELKS | Hearing and Balance Center

Services provided by St. Luke's

Case #1

- Passed AABR hearing screening
- Born at 35 weeks 6/7 days
- NICU stay less than 5 days
- Referred to audiology for risk indicator monitoring (Ototoxic medications)
- No family history of childhood hearing loss
- No history of otitis media

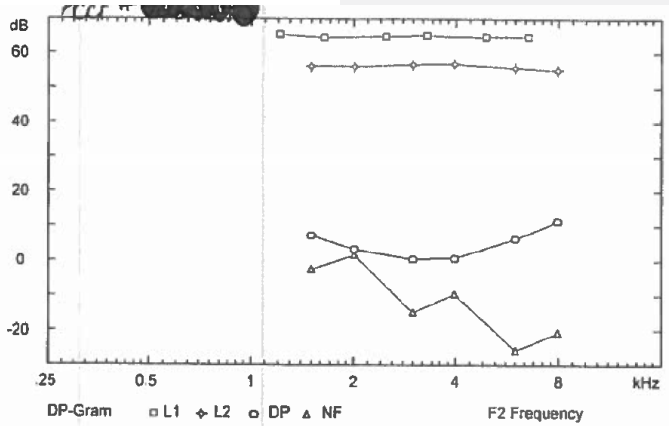
Audiology Evaluation
9 months old



LEFT	KEY	RIGHT
X(□)	AIR CONDUCTION (MASKED)	O(△)
> (□)	BONE CONDUCTUION (MASKED)	< (□)
SF	SOUND FIELD	SF
A	AIDED	A
CI	COCHLEAR IMPLANT	CI

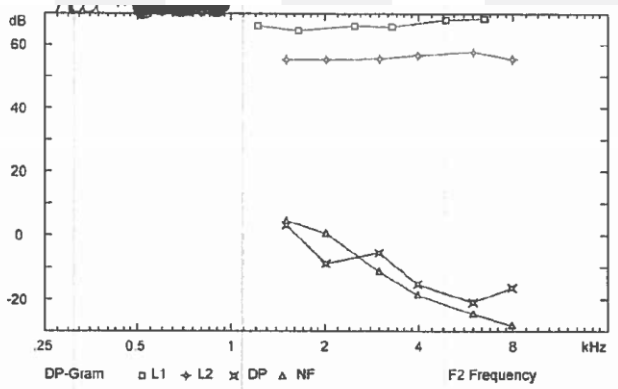
	PHONE RIGHT	PHONE LEFT	BINAURAL	UNAIDED	AIDED
PREDICTED SRT (PTA)	dB	dB	dB	dB	dB
OBTAINED SRT (SAT) (QUIET)	30 dB	40 dB	20 dB	dB	dB
MAXIMUM COMFORT LEVEL	dB	dB	dB	dB	dB
TOLERANCE THRESHOLD	dB	dB	dB	dB	dB
	dB	dB	dB	dB	dB
SDS ● _____ dB HTL QUIET	%	%	%	%	%
SDS ● _____ dB HTL QUIET	%	%	%	%	%
SDS					

Otoacoustic Emissions



Right: 22-Jan-13: -: 750-8000 Hz Diagnostic Test - High Noise: 13A22D01.OAE

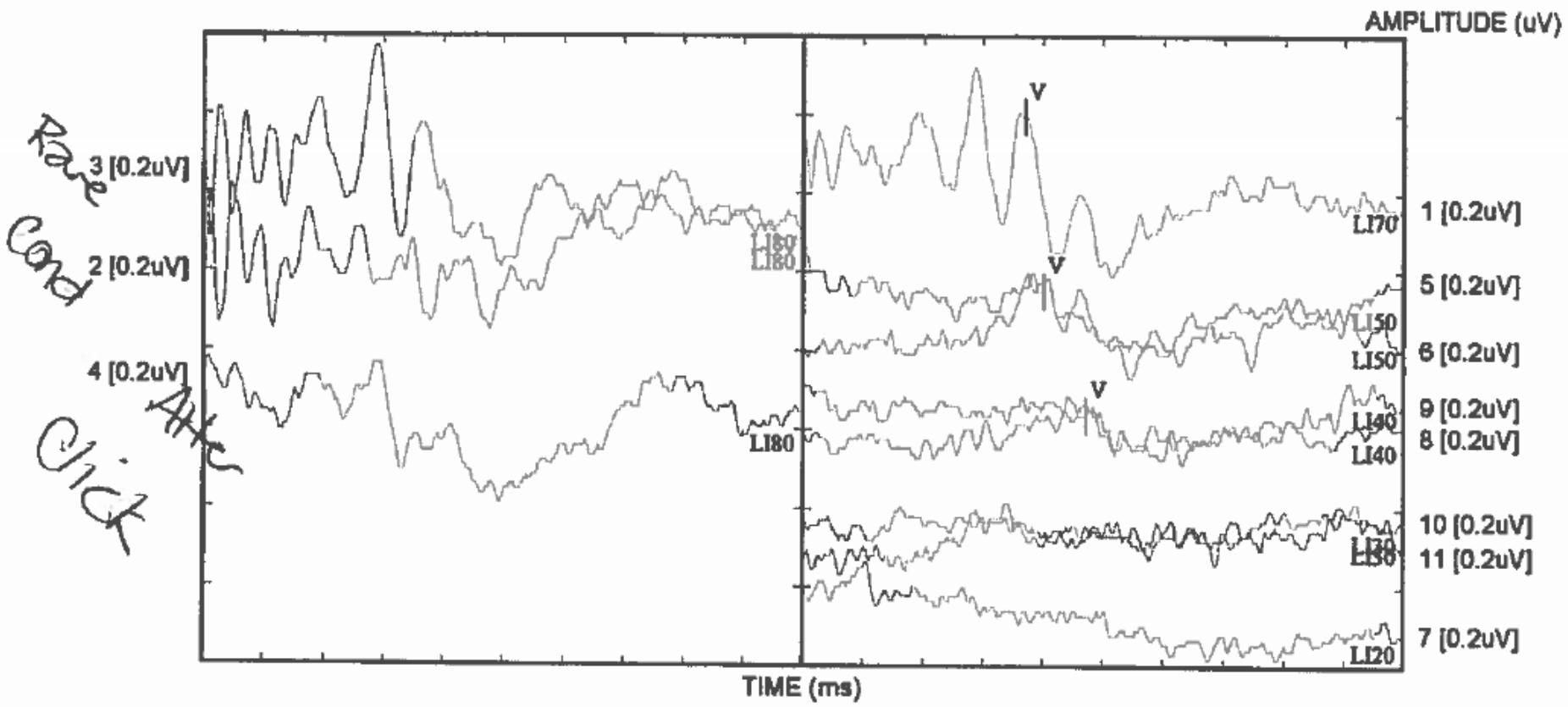
L1(dB)	L2(dB)	F1(Hz)	F2(Hz)	GM(Hz)	DP(dB)	NF(dB)	DP-NF(dB)
64.9	55.5	6516	7969	7206	11.5	-20.6	32.1
64.7	55.9	4922	6000	5434	6.4	-25.8	32.2
65.1	56.9	3281	3984	3616	0.7	-9.4	10.1
64.7	56.9	2484	3000	2730	0.5	-14.8	15.3
64.7	56.2	1641	2016	1818	3.2	1.6	1.6
65.3	56.2	1219	1500	1352	7.1	-2.7	9.8



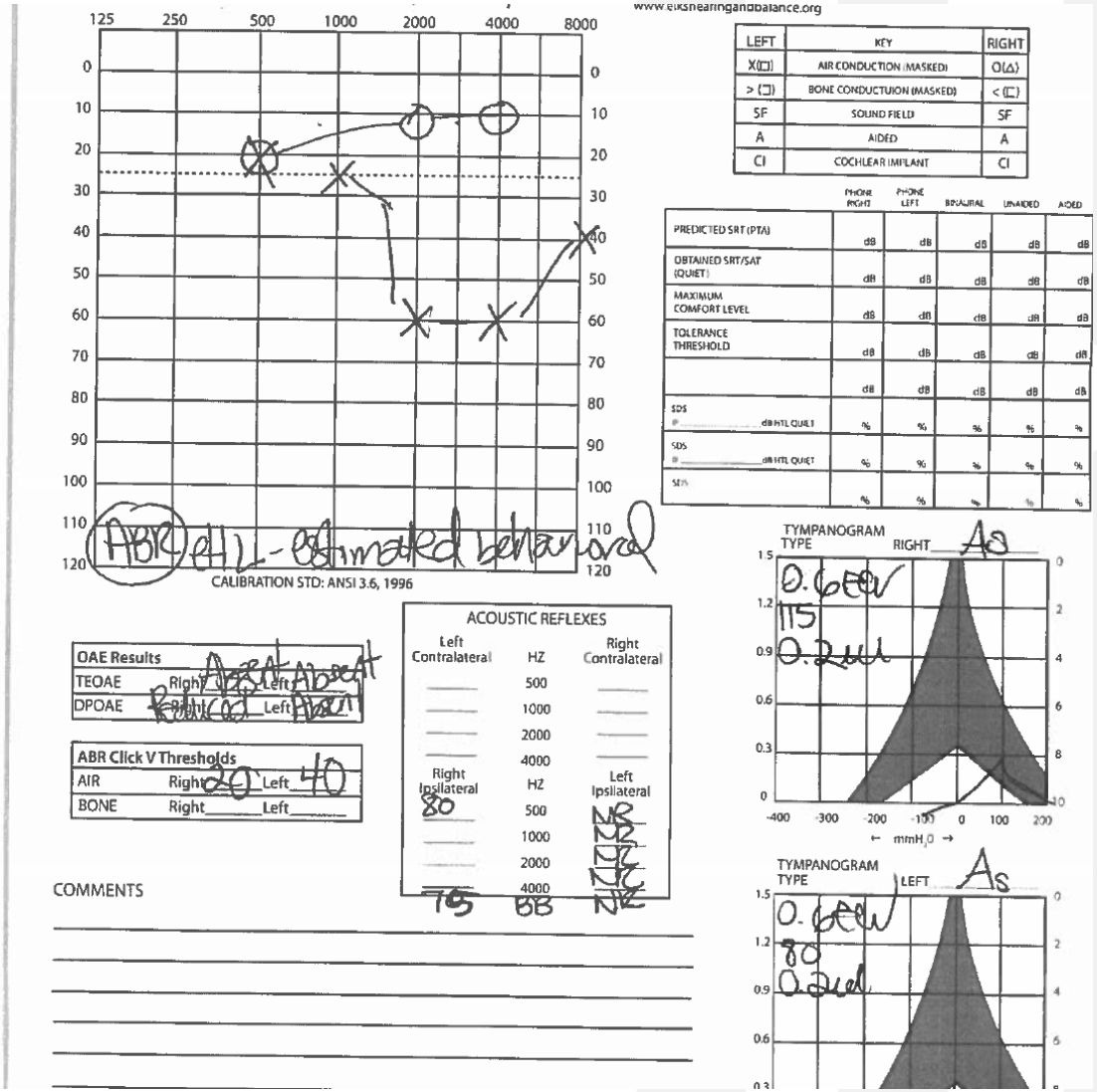
Left: 22-Jan-13: -: 750-8000 Hz Diagnostic Test - High Noise: 13A22D00.OAE

L1(dB)	L2(dB)	F1(Hz)	F2(Hz)	GM(Hz)	DP(dB)	NF(dB)	DP-NF(dB)
68.3	55.6	6516	7969	7206	-16.4	-28.1	11.7
68.0	57.8	4922	6000	5434	-20.9	-24.6	3.7
65.7	56.6	3281	3984	3616	-15.5	-18.8	3.3
66.1	55.7	2484	3000	2730	-5.7	-11.4	5.7
64.5	55.3	1641	2016	1818	-8.9	0.4	-9.3
65.9	55.3	1219	1500	1352	3.0	4.5	-1.5

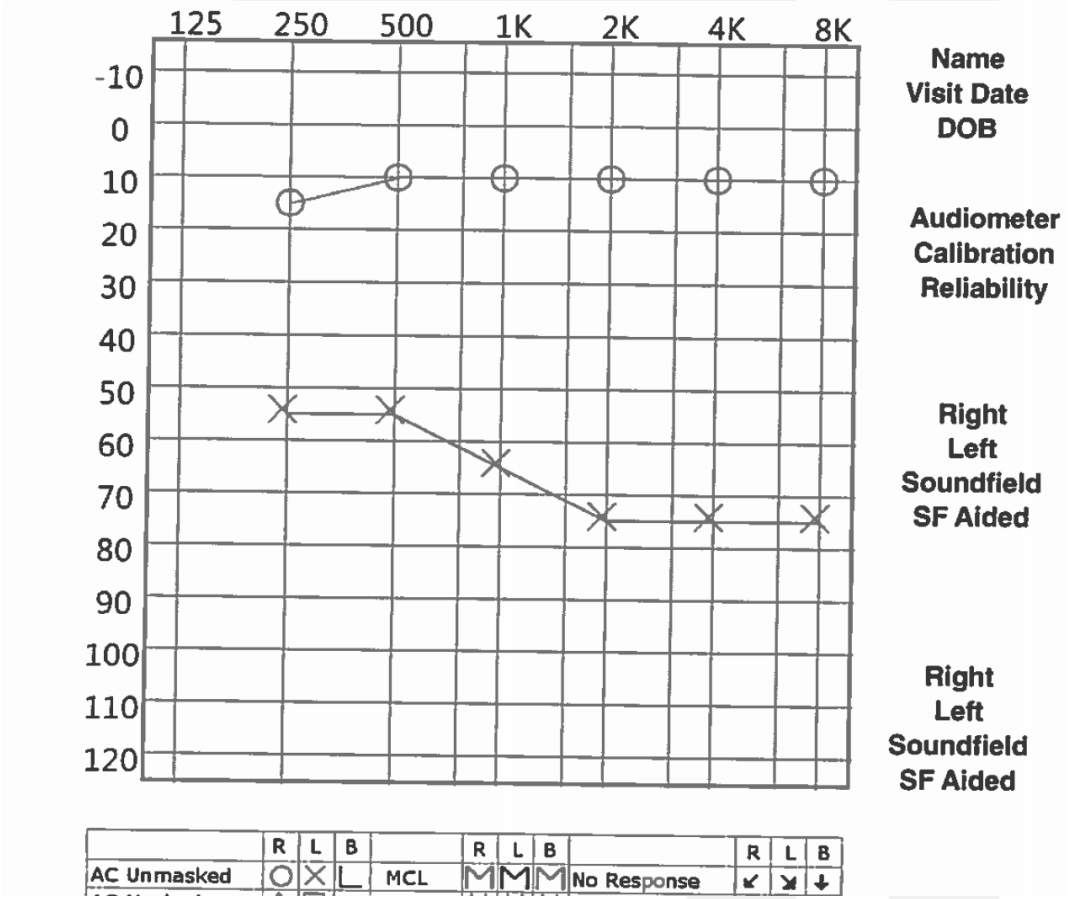
ABR evaluation
10 months old



ABR eHL



3 years old



Future research

Questions and Answers