

# Michigan Early Hearing Detection and Intervention (EHDI)

## Program Report 2011

2004-2008 Data



*Michigan Department  
of Community Health*



Rick Snyder, Governor  
Olga Dazzo, Director



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and Intervention Program

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## EHDI Background

The Michigan Early Hearing Detection and Intervention (EHDI) Program began in 1997 and is housed in the Michigan Department of Community Health (MDCH). MDCH strives for a healthier state by 1) promoting access to the broadest possible range of quality services and supports, 2) taking steps to prevent disease, promote wellness and improve quality of life, and 3) striving for the delivery of those services and supports in a fiscally prudent manner. MDCH receives funding from the federal Maternal and Child Health Services Block (MCHB) Grant, Title V of the amended Social Security Act of 1935, in order to ‘improve the health of all mothers and children, including children with special health care needs.’ The EHDI Program helps to achieve the MCHB grant objectives and the Healthy People 2020 early hearing screening and intervention objectives for MDCH. Since 2000, the EHDI Program has been supported by state funding and by grants awarded by the Centers for Disease Control and Prevention (CDC) and the MCHB Grant from the Health Resources and Services Administration (HRSA) in the U.S. Department of Health and Human Services. EHDI has also received funding from the Michigan Newborn Screening Card fees since 2007.

The EHDI Program works in collaboration with hospitals, clinics, parents, and audiologists to identify infants with hearing loss and follows them to enrollment in intervention services. The CDC, along with state representatives and other national agencies, developed national goals, objectives, and performance indicators to improve screening, hearing loss detection and early enrollment in intervention services.<sup>1</sup>

The national EHDI goals are as follows:

- **Goal 1:** All newborns will be screened for hearing loss no later than **1 month** of age, preferably before hospital discharge.
- **Goal 2:** All infants who screen positive for hearing loss will have a diagnostic audiologic evaluation no later than **3 months** of age.
- **Goal 3:** All infants identified with hearing loss will receive appropriate early intervention services no later than **6 months** of age.
- **Goal 4:** All infants and children with late onset, progressive or acquired hearing loss will be identified at the earliest possible time.
- **Goal 5:** All infants with hearing loss will have a medical home.
- **Goal 6:** Every state will have a complete EHDI Tracking and Surveillance System that will minimize loss to follow-up.
- **Goal 7:** Every state will have a comprehensive system that monitors and evaluates the progress towards the EHDI Goals and Objectives.

The first three national EHDI goals are commonly referred to as the “1-3-6 goals” and the CDC collects EHDI data from each state through the ‘CDC EHDI Hearing Screening and Follow-up Survey’ to assess progress toward these goals.<sup>2</sup>

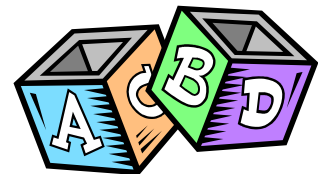
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## Hearing Screening Legislation in Michigan

Since February 23, 2006, with the passing of the Public Act 31, health professionals have been mandated to report results of hearing screens on infants less than twelve months of age and on children who have been diagnosed with hearing loss up to three years of age. The hearing loss report must include type, degree, and symmetry of the hearing loss as well as the site and date of the diagnosis. Along with the mandate to report results of hearing screens and hearing loss diagnoses, Michigan law established a quality assurance advisory committee which recommends policies and determines fees to support follow-up and surveillance efforts for the metabolic program. In April 2008, the quality assurance advisory committee mandated that hearing screening be included in the mandatory newborn screening panel. Since 2003, 100% (n=89) of birthing hospitals in Michigan perform newborn hearing screens.

## Medical Home

Medical homes provide comprehensive care by partnering with individuals and their medical providers and allow for better access to care by centralizing information. Medical homes can help to ensure that infants with hearing loss receive appropriate and timely services. EHDI works to provide notification of all hospital hearing screen referrals to providers for care coordination and medical evaluation, but this can be difficult due to incorrect provider information received with the screen result. To help ease this problem, physicians are able to notify EHDI of any incorrect provider information through the EHDI fax system. EHDI is also able to use the Michigan Care Improvement Registry (MCIR), the data system for child and adult immunization and other health information, to correct medical home information. Working with hospitals to identify correct provider and maternal contact information before discharge helps to ensure that all infants receive appropriate services in a timely manner.



## Benefits of Early Detection of Hearing Loss

Infants who are diagnosed with hearing loss should be enrolled in intervention services no later than six months of age. Research has shown that early identification of hearing loss and enrollment in intervention services may lead to significant benefits in childhood development, including improvements in emotional development, language, learning, and social skills.<sup>3</sup> Intervention is needed to maximize the critical period of language development in early childhood. Researchers found that children who were enrolled in intervention services by six months had significantly higher speech, reading abilities, and language comprehension scores than did children who were enrolled later.<sup>4</sup>

## Risk Factors for Hearing Loss

Congenital hearing loss (hearing loss present at birth) can be caused by a variety of factors. About half of all congenital hearing loss cases are caused by genetic factors. Hearing loss can be a

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characteristic of some genetic disorders such as Down syndrome or Usher syndrome.<sup>5</sup> Some non-inherited risk factors for congenital hearing loss include: prenatal infections such as cytomegalovirus (CMV) or rubella; maternal conditions such as diabetes; maternal exposure to toxins during pregnancy; prematurity; or lack of oxygen shortly after birth.<sup>5</sup> Hearing loss can also be acquired or developed any time after birth and can be caused by head injury, noise exposure, or as a result of some diseases such as influenza, chicken pox, or measles.<sup>5</sup> A more complete list of risk factors can be found in Appendix A.

The Joint Committee on Infant Hearing (JCIH) 2007 Position Statement states that all infants with a risk factor for hearing loss should be referred for a diagnostic audiologic evaluation at least once by 24 to 30 months of age, but earlier and more frequent evaluations should be performed on infants with some risk factors such as CMV infections, trauma, or family history of hearing loss.<sup>6</sup> The JCIH Position also states that all infants with or without risk factors should continue to be evaluated for communication development. The complete position statement from JCIH can be found at: [www.jcih.org](http://www.jcih.org).

### Public Health Impact of Hearing Loss

Hearing loss in infants is one of the most common birth defects. In Michigan, the prevalence of hearing loss is about one to three cases per 1,000 live born infants. Nationally, more than 12,000 babies in the United States (US) are born with hearing loss each year.<sup>7</sup> Infants who are not diagnosed early and do not receive early and appropriate intervention services are at risk of delayed language skills and social development. Of infants with a diagnostic evaluation during 2008 in Michigan, about 54% had an evaluation by three months of age, about 21% by six months of age, and about 26% later than six months of age. Moreover, infants lost to follow-up are at risk of delayed development. High loss to follow-up rates are a significant problem for EHDI programs across the US as well as in Michigan. In Michigan, about 62% of infants referring from their final screen did not receive needed follow-up services in 2008.



Hearing loss has a large economic impact for families in the US. In the US, the estimated *lifetime* educational cost of permanent hearing loss is about 115,600 dollars per child with no other disabilities (calculated for 2007).<sup>8</sup> Furthermore, the expected total lifetime costs (in 2003 dollars) for all people with hearing loss born in 2000, will be about 2.1 billion dollars. This cost includes direct costs such as doctor visits, assistive devices, home and automobile modifications, and special education, as well as indirect costs such as the value of lost wages due to limited type and amount of work that may be performed by those with hearing loss.<sup>9</sup> Prevention and early intervention services, such as those provided by the EHDI Program, are needed to help decrease the economic costs associated with hearing loss, and to help increase the percentage of children receiving early intervention services which aids in childhood social and language development.



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# Technical Notes and Definitions

## Technical Notes

All EHDI data for infants born from 2004 to 2008 for this report are current as of Spring 2010. To obtain demographic information, live birth records were linked to EHDI data using the birth certificate number as a common, unique identifier. To date, information on infants born in 2008 is the most current data available to the EHDI Program due to the amount of time needed to receive screening and diagnostic reports from health professionals. Live birth information used to calculate prevalence rates for each year was obtained from the Division of Vital Records and Health Statistics in the MDCH.

## EHDI Data System

The EHDI Program has an electronic data system for tracking results of newborn hearing screens and diagnoses, as well as an early intervention database for infants diagnosed with hearing loss to track enrollment in appropriate services and to provide information on amplification devices. The electronic data system was completed in December 2003 and is contained within the metabolic Newborn Screening (NBS) database system with Perkin Elmer, Inc. The electronic data system has a *data entry* component in which hearing screen and diagnostic results with limited demographic information are scanned and manually entered into the system, and a *follow-up* component in which form letters are generated for all cases needing follow-up. Based on the automated follow-up system, letters for infants with refers, missed screens, and incomplete screens are faxed to parents and providers (physicians, outpatient designated (re)screen sites, otologists, local public health offices, and Part C coordinators). Monthly reports for missing or incomplete screens are sent to birthing hospitals so that they can follow-up or submit screen results, if available. Quarterly statistical reports are sent to each birthing hospital detailing hospital specific screening and refer rates as well as overall state data as a comparison.

## Reporting Protocols

- **Initial Screens**

There has been 100% participation in universal newborn hearing screening programs within all 89 of Michigan birth hospitals since 2003. Infants are screened for hearing loss using the Auditory Brainstem Response (ABR) or Otoacoustic Emissions (OAE) equipment, or a combination of both. The ABR measures electrical responses which stem from the auditory system from an external stimulus through small electrodes placed on the baby's head. The OAE measures sound generated by the cochlea in response to an external stimulation by placing a probe in the baby's ear. Michigan collects data on the following screening techniques: Auditory Brainstem Response (ABR), Automated Auditory Brainstem Response (A-ABR), Distortion Product Otoacoustic Emissions (DPOAE), and



Infant receiving a hearing screen.

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Transient Evoked Otoacoustic Emissions (TEOAE). Hospitals can report results of the initial screen in one of two methods: 1) via metabolic hearing card that is mailed to EHDI and scanned into the data system or 2) via Electronic Birth Certificate (EBC) hearing report which is manually entered into the EHDI data system. About 1,000 births per year in Michigan occur at home with a midwife. Increased outreach to midwives is needed because hearing screens are usually not completed for infants in their care. Infants in the Neonatal Intensive Care Unit (NICU) or who are transferred to another hospital also present challenges in follow-up due to tracking difficulties and infants having complex medical issues.

- **Outpatient (Re)screens**

Results of outpatient hearing screens or re-screens are reported by primary care providers, designated referral sites, audiologists, otolaryngologists (ENTs), and local public health offices. Results can be reported through a variety of methods including: 1) EHDI reporting form, 2) returned hospital reports for missing or incomplete cases, or 3) returned provider follow-up faxes. Re-screen results are then entered into the data system by EHDI staff. A directory of hospital designated referral sites is maintained and updated frequently so that follow-up letters are sent to correct locations to ensure infants are referred to sites with appropriate testing equipment and knowledgeable staff.

- **Diagnoses**

Results of audiologic diagnostic evaluations are reported by pediatric audiologists and otolaryngologists (ENTs). Children with confirmed hearing loss, undetermined hearing loss, or with normal hearing are reported to EHDI. A complete list of hearing loss diagnoses reported to EHDI can be found in Appendix B. EHDI receives diagnostic results via the following methods: 1) EHDI reporting form, 2) diagnostic reports, 3) Children's Special Health Care Services (CSHCS) reports, and 4) returned provider fax reports. A directory of pediatric audiology sites is maintained and updated quarterly. Reporting of progressive hearing loss continues to be a challenge to EHDI as audiologists often do not report repeat diagnostic evaluation results.



- **Early Intervention**

EHDI collects early intervention (EI) data for all children diagnosed with hearing loss. Data collected includes enrollment into Part C services (Early On®); follow-up for audiological services including audiology monitoring, amplification services, and cochlear implantation; family support; and medical intervention information including genetics, ENT, and ophthalmology visits. EI information is voluntarily reported by Part C county coordinators with parental consent. EI information is also collected through home visits with families of newly diagnosed infants through the Guide By Your Side (GBYS) Program. Because Part C is not mandated to report EI information and because of the Family Educational Rights and Privacy Act (FERPA), receiving this information can be challenging for EHDI.

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## Quality Assurance

The EHDI Program engages in multiple quality assurance activities to ensure accuracy of information and proper security of data. The accuracy and quality of data is monitored through methods such as data linkages with other programs, 100% verification of hearing loss cases by staff, 100% double entry of demographic data, and verification of missing and duplicate cases to vital records and metabolic records. Activities related to security of information include annual staff Health Insurance Portability and Accountability Act (HIPAA) training, a HIPAA compliant notification release on all faxes, and data disposal and shredding. The EHDI Program has an evaluation plan which ensures effective use of data and can be used to evaluate the program and identify program priorities. The evaluation plan can be found in Appendix C.

To further ensure accurate data and reporting methods, EHDI offers training opportunities to hospital screening staff, physicians, and audiologists. Educational opportunities include:

- The EHDI web page relaying information to pediatricians and primary care providers on objective methods used to complete screenings, action steps for infants who refer from screening, risk factors associated with hearing loss, and available resources.
- A physician's information packet for infants diagnosed with hearing loss containing literature on intervention services, follow-up checklists, audiology sites, amplification devices, and community specific resource brochures.
- A newborn hearing screener online training course, started in January 2009, detailing correct screening methods for hospital screening staff. This course includes a pre and post assessment questionnaire to track knowledge before and after completing the course. To date, over 500 individuals have accessed the training course.
- Site visits to birth hospitals and audiology diagnostic centers discussing audiology practices, providing information, and educating on referrals to services available to families.
- The State EHDI Conference with speakers presenting on topics related to hearing loss, testing procedures, educational services, and many others, with additional opportunities for parents of children with hearing loss. The annual conference has about 150 to 180 attendees each year.

## Linkages to Other Data Systems

EHDI collaborates with other programs and data systems to ensure accurate data and timely hearing loss detection and to help improve follow-up for infants diagnosed with hearing loss. EHDI shares data with the following:

- **Electronic Birth Certificate (EBC) and the Michigan Care Improvement Registry (MCIR)**
  - EHDI relies on data linkage with the metabolic database to the EBC, or live birth records, which allows for loading data into MCIR. It also allows for the capability of capturing demographic information (such as race, ethnicity, health insurance, and education) on both the mother and child.

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- Linkage to EBC allows for identification of missing newborn hearing results in the EHDI system.
  - Since June 2009, EHDI results have been available on MCIR. Infants needing hearing screen follow-up are highlighted so that providers and public health nurses know to take action.
  - **Early On® (Part C) and Project Find (Part B)**
    - EHDI collaborates with the Michigan Department of Education to identify children enrolled in intervention services for hearing loss.
    - Collaboration can be difficult due to HIPAA and FERPA regulations which control the sharing of confidential information.
  - **Children's Special Health Care Services (CSHCS)**
    - Reports of infants born after 1997 and enrolled in CSHCS for hearing loss are shared with EHDI.
    - EHDI works with the audiologist responsible for CSHCS enrollment eligibility for hearing loss, hearing aids, and cochlear implants.
  - **Genetics**
    - EHDI participates in the Region 4 Genetics Collaborative to discuss genetic risk factors for hearing loss and to develop brochures and guidelines for providers.
  - **Michigan Birth Defects Registry (MBDR)**
    - Reports of infants with hearing loss are shared between MBDR and EHDI as a method of verifying cases found by both programs. Case sharing helps ensure accurate reporting of diagnoses to improve follow-up efforts.
  - **Local Public Health**
    - EHDI continues to work with local public health offices by referring infants with failed screens who have not had a hearing outcome reported to the state EHDI Program by 60 days of age.
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## Definitions

**Complete initial screen (complete hospital screen):** A pass/refer type of hearing test designed to identify newborns who require additional audiological assessment to rule out or confirm the presence of hearing loss. This is the first hearing screen an infant receives, usually at the hospital, before discharge.

**Hearing loss:** The Joint Committee on Infant Hearing (JCIH) defines hearing loss for universal newborn hearing screening programs as permanent bilateral or unilateral, sensory or conductive hearing loss, averaging 30 to 40 dB or more in the frequency region important for speech recognition (approximately 500 through 4000Hz).

**Hearing re-screen:** A subsequent hearing screen needed after having a refer result on a previous screen or if an infant has any risk factors for hearing loss. This allows for additional screening to determine if a diagnostic audiological assessment is needed.

**Hearing screening rate:** The proportion of infants with a complete hospital screen among the total number of live births in the specific time period.

*Calculation for hearing screening rate: number of infants with a complete initial screen in specific time period / number of live births in the specific time period (X 100).*

**Incomplete initial screen:** The first screen an infant receives at the hospital that is not completed due to a number of factors: infant was in the Neonatal Intensive Care Unit (NICU), transferred to another facility, discharged prior to screening, was restless, died, there was an equipment problem, environmental noise, parental refusal, or for another reason.

**Loss to follow-up (LTF):** Infants who do not receive or have no documentation of needed services after referring from the final hearing screen.

*Calculation for LTF: number of infants with no documentation in specific time period / number of infants referring from their final screen in specific time period (X 100).*

**Missed hearing screen:** A hearing screen not performed before hospital discharge.

**Prevalence rate of hearing loss:** The proportion of infants with hearing loss among all infants born in a given time period.

*Calculation for prevalence of hearing loss: number of infants with hearing loss in specific time period / number of live births in specific time period (X 1,000 to determine number of cases per 1,000 live births).*

**Refer:** Screen result when an infant does not pass the hearing screen.

**Referral rate:** The proportion of infants who fail their initial screen among all those who complete the hospital screen.

*Calculation for referral rate: number of infants failing their last initial screen / number of infants with a complete initial screen (X 100).*

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## EHDI Data Overview: 2004-2008

The Michigan EHDI Program works to progress toward the national EHDI goals to ensure that: 1) all infants are screened for hearing loss no later than one month of age, 2) all infants who screen positive for hearing loss will have a diagnostic audiologic evaluation no later than three months of age, and 3) all infants identified with hearing loss will receive appropriate intervention services no later than six months of age. A brief summary of statistics for the EHDI Program from 2004 to 2008 is shown in Table 1.

**Table 1:** Summary of statistics from the Michigan EHDI Program, 2004-2008.

Indicator	Number	Percent
<b>Number of live births</b>	<b>631,168</b>	
Complete initial screen	601,194	95.3
<i>Complete initial screen by 1 month</i>	<i>587,236</i>	<i>97.7</i>
Refer from final screen	9,510	1.6
Diagnostic evaluation after referral from final screen	2,778	29.2
<i>Diagnosis by 3 months</i>	<i>1,657</i>	<i>59.6</i>
Enrollment in Early Intervention Services	316	37.4
<i>Enrollment by 6 months</i>	<i>130</i>	<i>41.1</i>
Loss to follow-up	6,794	71.4
Prevalence of permanent hearing loss	1.3 per 1,000 live births	
Prevalence of non-permanent hearing loss	0.9 per 1,000 live births	

In Michigan, from 2004 to 2008, there were 631,168 live births of which 95.3% (n=601,194) had a complete initial screen and of these infants, 97.7% (n=587,236) were screened no later than one month of age. Of infants with a complete screen, 1.6% (n=9,510) referred (did not pass) from the final screen.

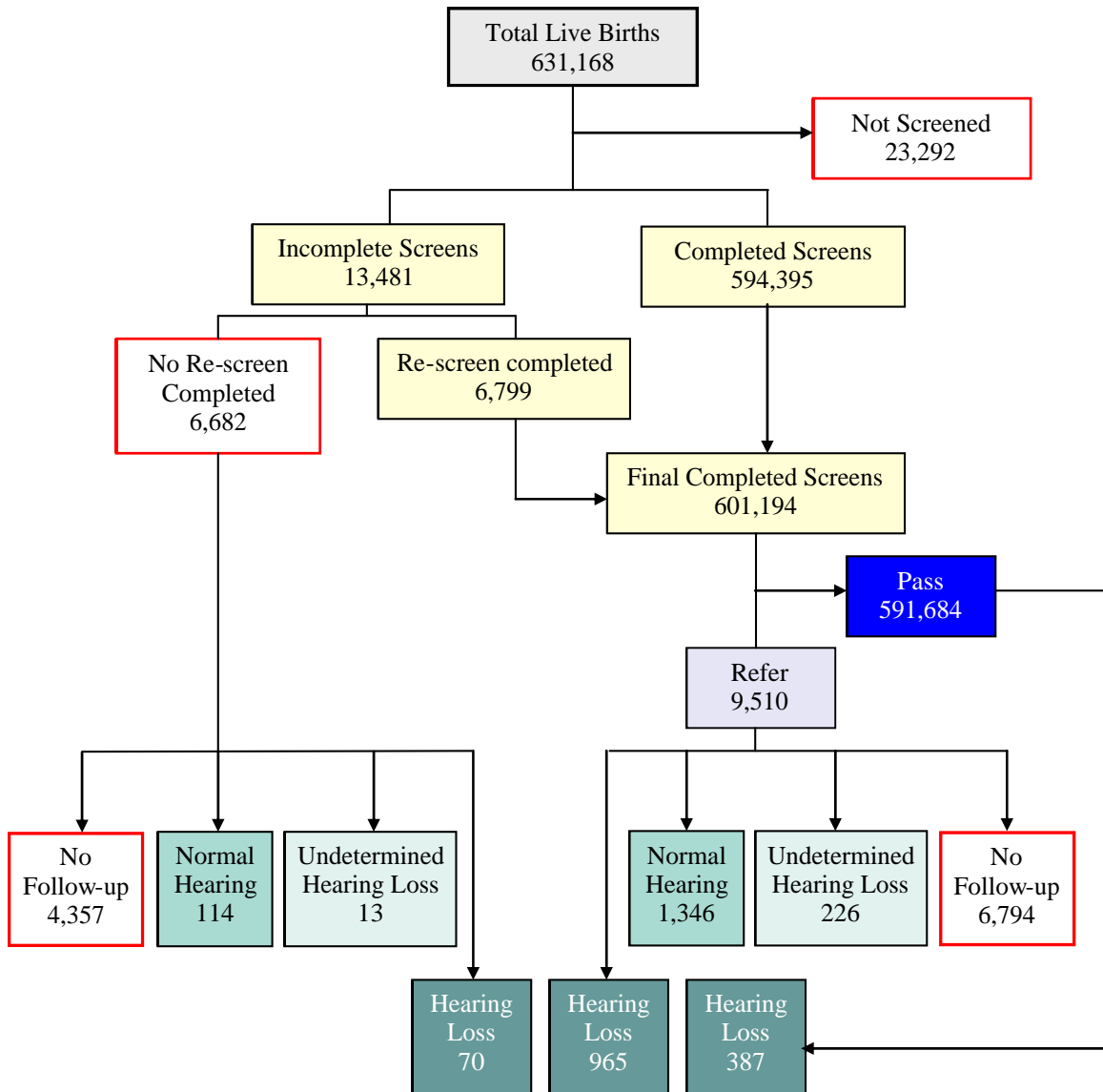
About 29% (n=2,778) of infants had a diagnostic evaluation after referring from the final hearing screen and of these infants, 59.6% (n=1,657) had an evaluation by three months of age. Overall from 2004 to 2008, the prevalence of permanent hearing loss was 1.3 infants per 1,000 live births and the prevalence of non-permanent hearing loss was 0.9 infants per 1,000 live births.

The EHDI Program has limited data on infants enrolled in early intervention services. For those whom the program has intervention data on, about 37% were enrolled in early intervention services and of those, about 41% were enrolled by six months of age.

Infants are considered lost to follow-up (LTF) when they do not receive a diagnostic evaluation after referring from the final screen. About 71% (n=6,794/9,510) of infants were lost to follow up in Michigan from 2004 to 2008.

The following page displays a flowchart showing the flow of infants through the EHDI system from birth to diagnosis. Infants have had diagnostic evaluations at multiple points throughout the EHDI system—after passing or referring from initial screens or re-screens, and after incomplete screens (Figure 1).

**Figure 1:** Flowchart of infants through the Michigan EHDI system, 2004-2008.



**Definitions:**

**Hearing Loss:** Includes both permanent and non-permanent hearing loss.

**Undetermined:** Type of hearing loss was not identified in diagnostic evaluation.

**Pass:** Passed **final** screening test in both ears.

**Refer:** Failed **final** screening test in one or both ears.

# Michigan EHDI Statistics, 2004-2008

## Screening Rates

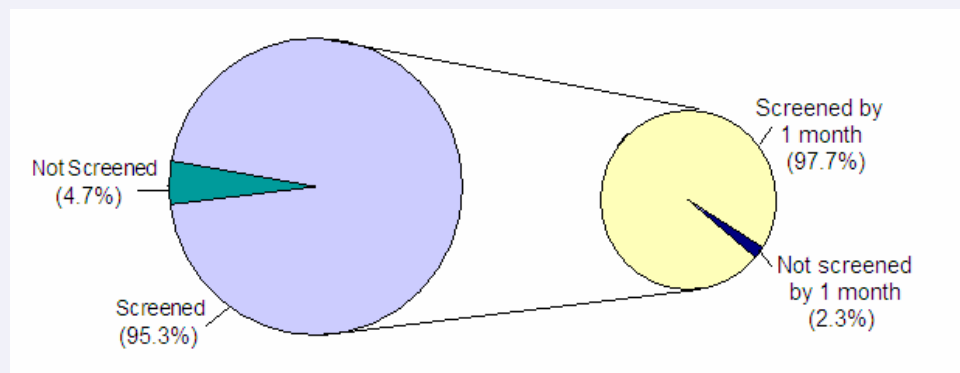
The first national EHDI goal states that all newborns should be screened for hearing loss no later than one month of age, preferably before hospital discharge and Michigan is successfully meeting this goal. Table 2 summarizes the number of live births, the percentage of infants with a complete hospital screen, and the percentage of infants screened no later than one month of age in Michigan from 2004 to 2008.

In Michigan, the number of live births decreased from 129,710 births in 2004 to 121,231 births in 2008. The percentage of infants with a complete hospital screen increased from 92.6% (n=120,067) in 2004 to 95.7% (n=116,281) in 2005 (Table 2). The percentage of infants with a complete screen remained at about 96% through 2008 primarily due to universal newborn hearing screening becoming a standard of care in 100% of birthing hospitals, since 2003.

The percentage of infants with a complete hospital screen by one month of age increased from 96.3% (n=115,638) in 2004 to 98.3% (n=114,285) in 2008 (Table 2). Figure 2 gives a summary of complete hospital screens and screens completed by one month of age among live births in Michigan from 2004 to 2008. Overall, 95.3% of infants had a complete hospital screen and of those, 97.7% were screened by one month of age (Figure 2).

**Table 2:** Complete hospital hearing screens and screens by one month of age: Michigan EHDI, 2004-2008.

Birth Year	Live Births	Complete Hospital Screen		Screened by 1 Month	
	Number	Number	Percent	Number	Percent
2004	129,710	120,067	92.6	115,638	96.3
2005	127,518	122,028	95.7	118,601	97.2
2006	127,537	122,500	96.1	120,386	98.3
2007	125,172	120,318	96.1	118,326	98.3
2008	121,231	116,281	95.9	114,285	98.3
<b>TOTAL</b>	<b>631,168</b>	<b>601,194</b>	<b>95.3</b>	<b>587,236</b>	<b>97.7</b>



**Figure 2:** Overall complete hospital hearing screens and screens by one month of age: Michigan EHDI, 2004-2008.



## Incomplete Initial Screens

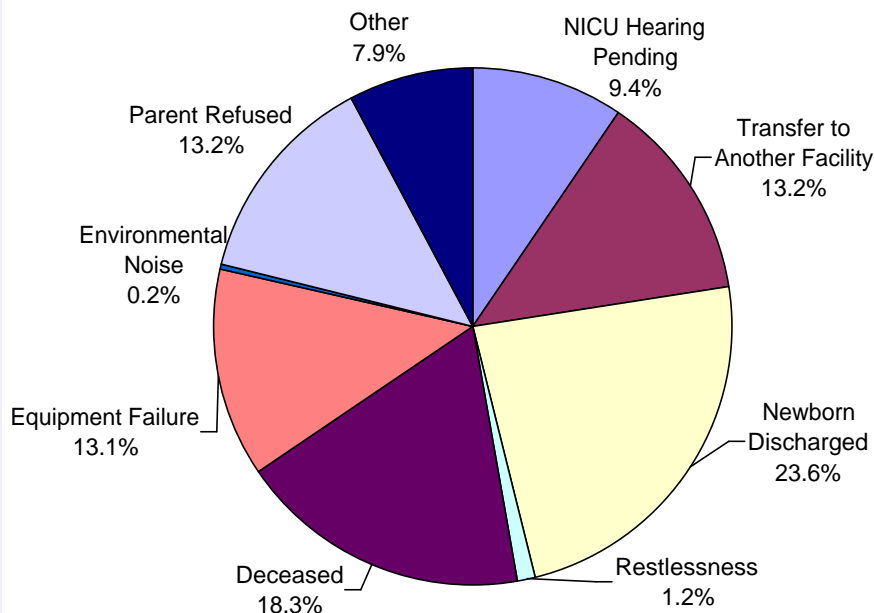
Incomplete hospital screens are those that were not able to be completed due to hospital, parental, and infant related issues, as well as others, as seen in Table 3. A total of 6,682 infants had an incomplete hearing screen with no further screening from 2004 to 2008 (Table 3).

Overall, incomplete screens were due to the following reasons: infant was in the Neonatal Intensive Care Unit (NICU)—9.4% (n=629); infant was transferred—13.2% (n=881); infant was discharged—23.6% (n=1,574); infant was restless—1.2% (n=81); infant died—18.3% (n=1,220); equipment failure—13.1% (n=875); environmental noise—0.2% (n=14); parental refusal—13.2% (n=879); some other reason—7.9% (n=529)(Table 3 and Figure 3).

Of note, the reasons for incomplete screens changed from 2004 to 2008. Main changes include: parental refusal *increasing* by 10.6%; being in the NICU *increasing* by 14.6%; and infant discharge *decreasing* by 34.5% (Table 3). These changes demonstrate the success of hospitals completing screens before infant discharge and that hospitals may need counseling on the handling of screens for infants in the NICU.

**Table 3:** Incomplete screens by reason for missing screen: Michigan EHDI, 2004-2008.

Reason for Incomplete Screen	2004-2008 Total		% Change from 2004 to 2008
	Number	Percent	
NICU Hearing Pending	629	9.4	14.6
Transfer to Another Facility	881	13.2	2.4
Newborn Discharged	1,574	23.6	-34.5
Restlessness	81	1.2	-1.4
Deceased	1,220	18.3	9.3
Equipment Failure	875	13.1	-4.4
Environmental Noise	14	0.2	-0.3
Parent Refused	879	13.2	10.6
Other	529	7.9	3.7
<b>Total Number</b>	<b>6,682</b>		



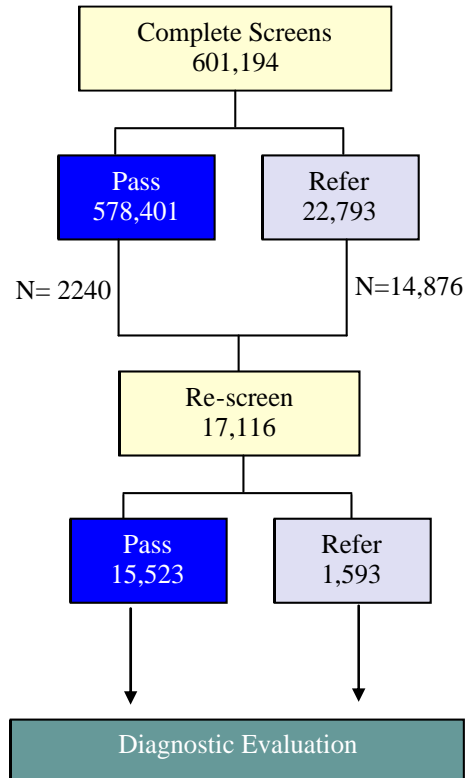
**Figure 3:** Overall reasons for incomplete screens: Michigan EHDI 2004-2008.

## Refer Rates

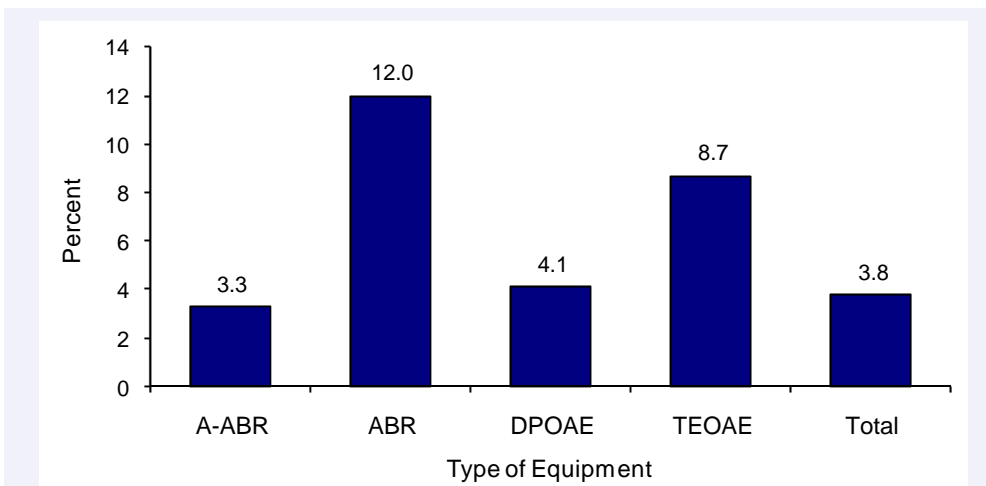
The refer rate is the proportion of infants who refer from a complete screen among those with a complete screen. Here, we expand the flow chart found in Figure 1, page 15, to include both the initial complete screens and re-screens (Figure 4). According to EHDI protocol, infants who refer from the complete hearing screen should have one subsequent re-screen to determine if further testing is needed. Nationally, the refer rate is recommended to be below 4%, and Michigan is meeting this goal.

From 2004 to 2008, 3.8% (n=22,793) referred from the complete screen. The refer rate increased from 3.6% in 2004 to 4.0% in 2008 (Table 4, page 19). It is important that the refer rate remain low so that infants do not receive unnecessary testing as many of those who refer from a screen do not in fact have hearing loss. A total of 17,116 infants had a re-screen after passing (n=2,240) or referring (n=14,876) from the complete screen (Figure 4). Infants may be screened after passing the initial screen if they have a risk factor for hearing loss.

More detailed information on refer rates by type of testing equipment are given in Table 4 and Figure 5. Overall, 3.3% (n=11,742) of those screened with A-ABR referred, 12.0% (n=1,385) of those screened with ABR referred, 4.1% (n=9,338) of those screened with DPOAE referred, and 8.7% (n=328) of those screened with TEOAE referred from the complete hospital screen from 2004 to 2008 (Table 4 and Figure 5). The ABR refer rate may be high because it is usually performed on those in the NICU, with risk factors for hearing loss. The DPOAE refer rate may be low due to infants having repeat screens until receiving a pass result.



**Figure 4:** Flowchart of infants from complete hospital screen to re-screen: Michigan EHDI, 2004-2008.



**Figure 5:** Refer rates from completed hospital hearing screen by type of screening equipment: Michigan EHDI, 2004-2008.

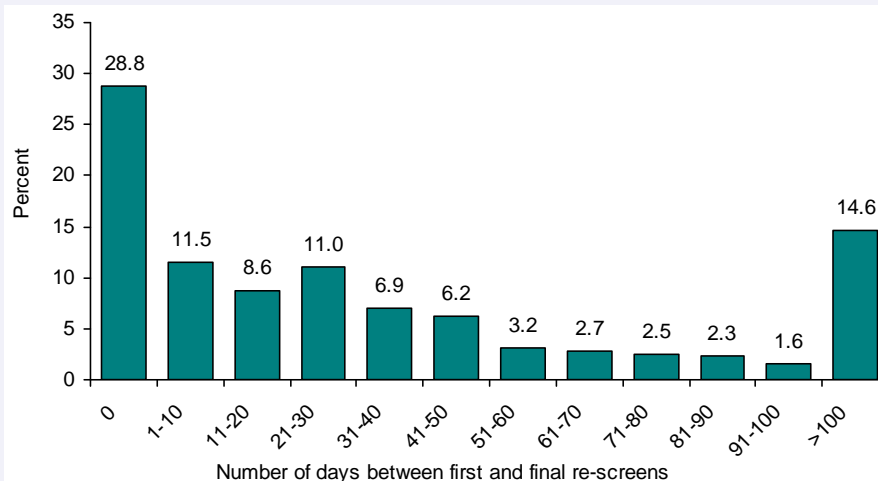
**Table 4:** Refer rates from completed hospital hearing screen by type of screening equipment: Michigan EHDI, 2004-2008.

Birth Year	AABR		ABR		DPOAE		TEOAE		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
2004	2,130	2.9	297	11.8	1,889	4.4	45	4.9	4,361	3.6
2005	2,101	2.9	252	10.5	2,065	4.6	50	5.4	4,468	3.7
2006	2,327	3.3	282	11.8	1,715	3.7	92	9.0	4,416	3.6
2007	2,619	3.7	286	14.3	1,806	3.9	129	15.2	4,840	4.0
2008	2,565	3.7	268	12.2	1,863	4.2	12	19.4	4,708	4.0
<b>Total</b>	<b>11,742</b>	<b>3.3</b>	<b>1,385</b>	<b>12.0</b>	<b>9,338</b>	<b>4.1</b>	<b>328</b>	<b>8.7</b>	<b>22,793</b>	<b>3.8</b>

## Multiple Screens

After referring from the complete hospital screen, infants should have **one** subsequent re-screen before one month of age, and should then be referred for a diagnostic audiologic evaluation. If an infant is screened many times, the result of the final screen may be inaccurate or the infant may not be referred to necessary services in a timely manner. Michigan EHDI data revealed that hospitals reported more than one complete hospital screen for about 0.4% (n=2,340) of infants from 2004 to 2008. Of infants with multiple hospital screens, 99.7% (n=2,335) had all screens within one day. Hospitals should only report the result of the final screen to EHDI.

Of the 17,116 infants who had a re-screen from 2004 to 2008, about 7% (n=1,238) had more than one re-screen. Of these infants, the median (middle) length of time between the first and final re-screen was 21.0 days, ranging from 0 to 1,839 days between first and final screens. Of infants with multiple re-screens, about 29% (n=356) had the first and final screen on the same day, while about 15% (n=181) had more than 100 days between the first and final screen (Figure 6). More detail on the number of days between screens for infants with a re-screen is given in Figure 6. When the number of days between multiple screens and diagnostic evaluation increases, infants are not diagnosed with hearing loss or determined to have normal hearing in a timely manner which can result in delayed childhood development and language skills, increased parent anxiety, and increased cost of medical care if the child has hearing loss.



**Figure 6:** Days between first and final screens for infants with a re-screen: Michigan EHDI, 2004-2008.

## Diagnostic Audiologic Evaluations

Information from diagnostic evaluations is reported to EHDI at many stages of the EHDI process. Infants may have a diagnostic evaluation after passing or referring from the complete hospital screen, or after an incomplete screen. Permanent and non-permanent hearing loss by orientation (unilateral or bilateral) and degree are reported to EHDI. Permanent hearing loss includes sensorineural, mixed, conductive permanent, and auditory neuropathy types while non-permanent hearing loss includes conductive transient types. Other diagnostic evaluation results reported to EHDI include hearing within normal limits and undetermined status. Table 5 gives a summary of the overall prevalence of hearing loss from 2004 to 2008.

**Table 5:** Prevalence of permanent and non-permanent hearing loss: Michigan EHDI, 2004-2008.

Diagnosis	Number of Infants	Rate (per 1,000 live births)
<b>Permanent</b>	<b>845</b>	<b>1.3</b>
Sensorineural	720	1.1
Mixed	60	0.1
Conductive Permanent	40	0.1
Auditory Neuropathy	25	0.04
<b>Non-Permanent</b>	<b>577</b>	<b>0.9</b>
Conductive	357	0.6
Conductive Transient	220	0.3

Nationally, about 1 to 3 infants per 1,000 births are diagnosed with permanent hearing loss, and in Michigan, from 2004 to 2008, the prevalence of permanent hearing loss was 1.3 cases per 1,000 live births reported to EHDI. Permanent hearing loss included rates of: 1.1 cases of sensorineural, 0.1 cases of mixed, 0.1 cases of conductive permanent, and 0.04 cases of auditory neuropathy, all per 1,000 live births (Table 5). The prevalence of non-permanent hearing loss was 0.9 cases per 1,000 live births reported to EHDI from 2004 to 2008. Non-permanent hearing loss included rates of 0.6 cases of conductive and 0.3 cases of conductive transient, both per 1,000 live births (Table 5).

The following pages analyze the results from diagnostic evaluations by a variety of factors, including:

- Permanent hearing loss by result of the final screen—to assess the stages in the EHDI system in which hearing loss is reported.
- Permanent and non-permanent hearing loss by race and ethnicity—to evaluate disparities in hearing loss among different populations.
- Prevalence of permanent and non-permanent hearing loss by orientation (unilateral or bilateral) and degree (mild-moderate or severe-profound)—to assess varying levels of hearing loss in Michigan infants.
- The percentage of infants with a diagnostic evaluation no later than three months of age—to assess how well the EHDI program is doing in achieving the national EHDI goal.

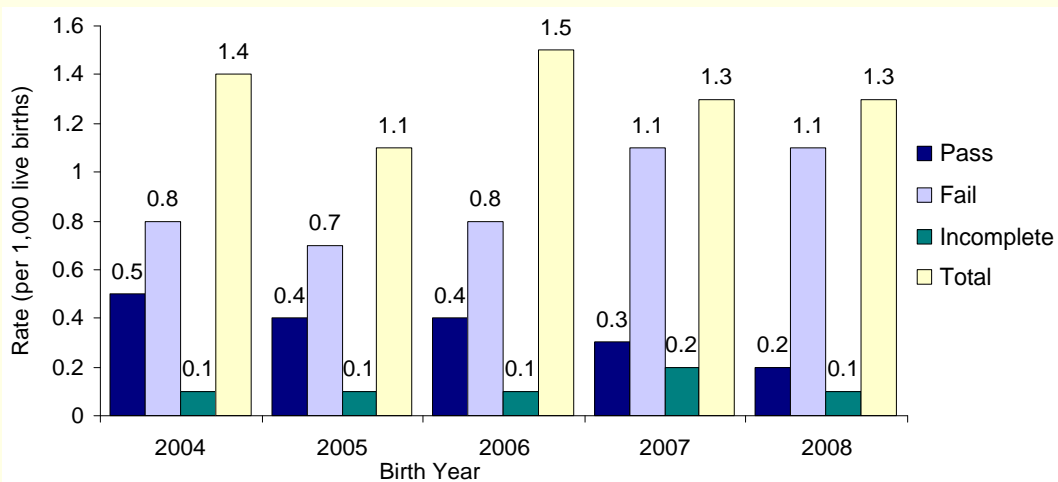
## Permanent Hearing Loss by Result of Final Screen

Prevalence of hearing loss should be analyzed by result of the final screen in order to assess the impact that EHDI has on the detection of hearing loss.<sup>10</sup> Infants diagnosed with hearing loss after a *failed* final screen are considered to be detected by EHDI processes, while infants diagnosed after a *passed* or *incomplete* final screen are considered detected by an outside source. The prevalence of **permanent** hearing loss by result of the final screen for infants born from 2004 to 2008 is shown in Table 6 and Figure 7. More detailed information on permanent hearing loss by result of the final screen for years 2004 to 2008 can be found in Appendix D. In this analysis, hearing loss was defined as permanent hearing loss (sensorineural, mixed, conductive permanent, or auditory neuropathy) of any orientation (unilateral or bilateral) or degree (mild, moderate, severe, or profound).

From 2004 to 2008, a total of 561 infants with hearing loss were detected by EHDI, while an additional 284 (n=219+65) infants were detected by outside sources, for a total prevalence of 1.3 children with permanent hearing loss per 1,000 live births (Table 6). The prevalence of permanent hearing loss detected by EHDI increased from 0.8 children per 1,000 live births in 2004 to 1.1 children per 1,000 live births in 2008. The prevalence of permanent loss detected from outside sources decreased from 0.5 children per 1,000 live births in 2004 to 0.2 children per 1,000 live births in 2008 (Figure 7).

**Table 6:** Prevalence of permanent hearing loss by result of final screen: Michigan EHDI, 2004-2008.

Birth Years	Final Screen Result		Permanent Hearing Loss	
	Result	Number	Number	Rate (per 1,000 live births)
2004 to 2008	Pass	591,684	219	0.3
	Fail	9,510	561	0.9
	Incomplete	6,682	65	0.1
	<b>Total Screened</b>	<b>607,876</b>	<b>845</b>	<b>1.3</b>



**Figure 7:** Prevalence of permanent hearing loss by final screen result: Michigan EHDI, 2004-2008.

## Hearing Loss by Race and Ethnicity

The prevalence of hearing loss was analyzed by race and ethnicity to assess any disparities among different populations. To date, little research has been done on the prevalence of hearing loss among different racial and ethnic populations. One study, using data from the Hispanic Health and Nutrition Examination Survey (HHANES) and the National Health and Nutrition Examination Survey II (NHANES II), found that the prevalence of self-reported hearing loss was higher among Hispanics, compared to blacks and non-Hispanic whites.<sup>11</sup> The authors note, however, that the study must be interpreted with caution due to the low prevalence of hearing loss which did not allow for detection of significant differences between races. Another study reports that blacks had a higher prevalence of more severe levels of hearing loss than whites.<sup>12</sup>

The prevalence of permanent and non-permanent hearing loss by race and ethnicity for infants born from 2004 to 2008 in Michigan is shown in Table 7. Of note, race categories include those of any ethnicity. Prevalence of **permanent** hearing loss was relatively constant across all races (white, black, and other) with a total of about 1.3 cases per 1,000 live births from 2004 to 2008, while the prevalence in Hispanics was about 4.3 cases per 1,000 live births from 2004 to 2008 (Table 7). From 2004 to 2008, the prevalence of **non-permanent** hearing loss was lowest among those who were of another race (neither black nor white) with 0.7 cases per 1,000 live births and was highest among those who were Hispanic with 2.4 cases per 1,000 live births (Table 7).

**Table 7:** Prevalence of permanent and non-permanent hearing loss by birth year and race/ethnicity: Michigan EHDI, 2004-2008.

Prevalence Rate of Permanent Hearing Loss <sup>1</sup>					
Birth Year	Total	White	Black	Other <sup>3</sup>	Hispanic
2004	1.4	1.4	1.2	*	4.5
2005	1.1	1.1	1.1	1.3	4.3
2006	1.3	1.3	1.1	1.4	2.9
2007	1.5	1.5	1.5	2.2	5.8
2008	1.3	1.2	1.1	1.2	4.1
<b>Total<sup>2</sup></b>	<b>1.3</b>	<b>1.3</b>	<b>1.2</b>	<b>1.4</b>	<b>4.3</b>
Prevalence Rate of Non-Permanent Hearing Loss <sup>1</sup>					
Birth Year	Total	White	Black	Other <sup>3</sup>	Hispanic
2004	0.6	0.6	0.5	*	1.9
2005	0.6	0.6	0.5	*	2.0
2006	1.3	1.1	2.0	1.1	3.7
2007	1.3	1.2	1.5	1.2	3.7
2008	0.9	0.7	1.0	*	0.7
<b>Total<sup>2</sup></b>	<b>0.9</b>	<b>0.8</b>	<b>1.1</b>	<b>0.7</b>	<b>2.4</b>

<sup>1</sup>Rates are per 1,000 live births.

<sup>2</sup>Those of other race (not white or black) and those with race not stated are included in the 'total' column.

<sup>3</sup>Encompasses those who do not define themselves as black or white and includes Native American, Asian/Pacific Islander, etc.

*An asterisk (\*) indicates that there were less than 5 cases in the specified population and time period.*

## Hearing Loss by Degree and Orientation

Audiologists diagnose and report hearing loss by degree and orientation. Orientation refers to hearing loss that is either bilateral (affecting both ears) or unilateral (affecting one ear). Degree of hearing loss focuses on severity and is expressed in decibels (dB) based on the average pure tone for the frequencies 500 to 4,000 Hz. For this analysis, degree of hearing loss was defined as follows: mild—21 to 40 dB, moderate—41 to 70 dB, severe—71 to 90 dB, and profound—91 dB or greater.<sup>2</sup>

Of note, the CDC recently revised reporting procedures for degree of hearing loss to include slight and moderately severe so that the new degree categories are as follows: slight—16-25 dB, mild—26-40 dB, moderate—41-55 dB, moderately severe—56-70 dB, severe—71-90, and profound—91 dB or greater. This new reporting procedure will begin in the next couple of years. EHDI is currently working to make these changes in their reporting system.

Prevalence of permanent and non-permanent hearing loss by degree and orientation is shown in Table 8. For this analysis, those with auditory neuropathy are **not** included as degree is not reported for this type. For **permanent** hearing loss from 2004 to 2008, there were: 0.5 children with mild-moderate bilateral loss; 0.5 children with severe-profound bilateral loss; 0.2 children with mild-moderate unilateral loss; and 0.1 children with severe-profound unilateral loss, all per 1,000 live births (Table 8). For **non-permanent** hearing loss, there were 0.5 children with mild-moderate bilateral loss and 0.4 children with mild-moderate unilateral loss, both per 1,000 live births from 2004 to 2008 (Table 8). There were no children with severe-profound non-permanent hearing loss. Children are affected by many different degrees of hearing loss and it is important to assess all levels of hearing loss so that appropriate services are available to all children.

**Table 8:** Prevalence of permanent and non-permanent hearing loss by degree and orientation: Michigan EHDI, 2004-2008.

Prevalence of Hearing loss (per 1,000 live births)					
Birth Year	Type of Hearing Loss	Degree			
		Bilateral		Unilateral	
		Mild-Moderate	Severe-Profound	Mild-Moderate	Severe-Profound
2004	Permanent	0.5	0.5	0.2	0.2
	Non-Permanent	0.3	*	0.3	*
2005	Permanent	0.5	0.4	0.1	0.1
	Non-Permanent	0.3	*	0.3	*
2006	Permanent	0.5	0.5	0.2	0.1
	Non-Permanent	0.8	*	0.5	*
2007	Permanent	0.5	0.5	0.3	0.2
	Non-Permanent	0.8	*	0.4	*
2008	Permanent	0.5	0.4	0.3	0.1
	Non-Permanent	0.5	*	0.4	*
Total	Permanent	0.5	0.5	0.2	0.1
	Non-Permanent	0.5	*	0.4	*

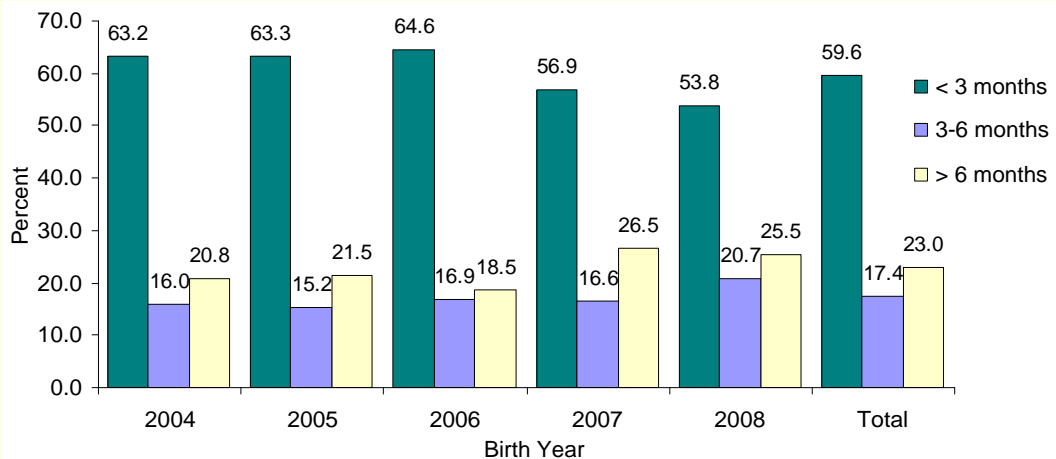
## Diagnostic Evaluation by 3 Months

The second national EHDI goal states that all infants who screen positive for hearing loss should have a diagnostic audiologic evaluation no later than three months of age. Nationally, this goal is not being met with about 60% of infants who refer from their hearing screen having no documented diagnosis.<sup>13</sup> It is important for infants with hearing loss to be diagnosed in a timely manner so that they may benefit from early intervention services.

From 2004 to 2008, a total of 29.2% (n=2,778) of infants referring from the final screen had a diagnostic evaluation in Michigan 2004 to 2008 (Table 9). Overall for infants referring from the final hearing screen from 2004 to 2008, 59.6% (n=1,657) had a diagnostic evaluation by three months of age, 17.4% (n=482) had an evaluation between three and six months of age and 23.0% (n=639) had an evaluation later than six months of age (Table 9). The percentage of infants diagnosed by **three months** of age decreased from 63.2% in 2004 to 53.8% in 2008. The percentage of infants diagnosed between **three and six months** increased from 16.0% in 2004 to 20.7% in 2008. The percentage of infants diagnosed later than **six months** of age increased from 20.8% in 2004 to 25.5% in 2008. Although the total percentage of infants with a diagnostic evaluation increased over the years, EHDI is not yet meeting the national EHDI goal and much effort is put into reducing loss to follow-up to ensure that babies who fail the final screen have a diagnostic audiologic evaluation. Activities related to reducing loss to follow-up can be found in the *EHDI Program Highlights* section on page 32 of this report.

**Table 9:** Age at diagnostic audiologic evaluation for infants referring from the final hearing screen: Michigan EHDI, 2004-2008.

Birth Year	Age at Diagnostic Evaluation							
	<3 months		3-6 months		>6 months		Total	
	Number	%	Number	%	Number	%	Number	%
2004	222	63.2	56	16.0	73	20.8	351	15.4
2005	271	63.3	65	15.2	92	21.5	428	23.7
2006	401	64.6	105	16.9	115	18.5	621	33.5
2007	405	56.9	118	16.6	189	26.5	712	37.0
2008	358	53.8	138	20.7	170	25.5	666	40.6
<b>Total</b>	<b>1,657</b>	<b>59.6</b>	<b>482</b>	<b>17.4</b>	<b>639</b>	<b>23.0</b>	<b>2,778</b>	<b>29.2</b>



**Figure 8:** Age at diagnostic audiologic evaluation for infants referring from the final hearing screen: Michigan EHDI, 2004-2008.



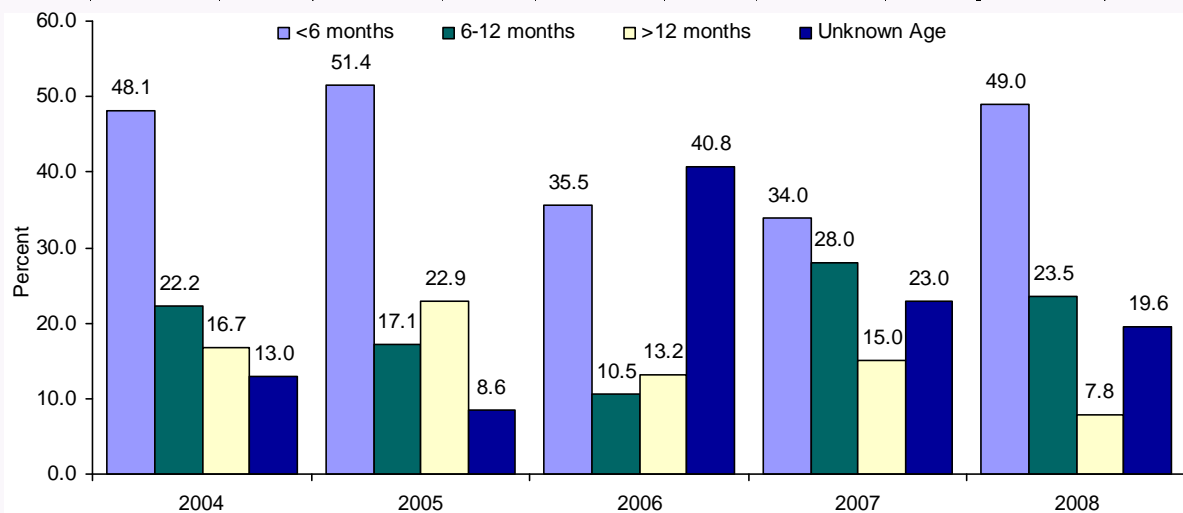
## Enrollment in Early Intervention Services

The third national EHDI goal is that all infants identified with hearing loss should receive appropriate early intervention services no later than six months of age. EHDI collects early intervention (EI) data for children diagnosed with hearing loss from Part C county coordinators and the Guide By Your Side (GBYS) program, with parental consent. Receiving this information can be difficult as Part C is not mandated to report information to EHDI and due to the Family Educational Rights and Privacy Act (FERPA). This section gives information on enrollment into Early On<sup>®</sup> (Michigan's Part C services), which assists children age zero to three years with developmental delays or a diagnosed disability.

Table 10 shows the percentage of infants diagnosed with permanent hearing loss and enrolled in intervention services from 2004 to 2008. From 2004 to 2008, 37.4% (n=316) of infants diagnosed with permanent hearing loss were enrolled in intervention services. Of infants diagnosed with permanent hearing loss from 2004 to 2008, 41.1% (n=130) were enrolled by six months of age, 20.9% (n=66) were enrolled between six and twelve months of age, 14.6% (n=46) were enrolled later than twelve months of age, and 23.4% (n=74) were enrolled at an unknown age (Table 9). In 2008, 32.7% of infants were enrolled in services but this percentage may increase as reports for infants who continue to be enrolled at later dates are sent to the EHDI program. Michigan is currently not meeting the national goal, but data is limited due to FERPA regulations.

**Table 10:** Age at enrollment in intervention services for infants diagnosed with permanent hearing loss: Michigan EHDI, 2004-2008.

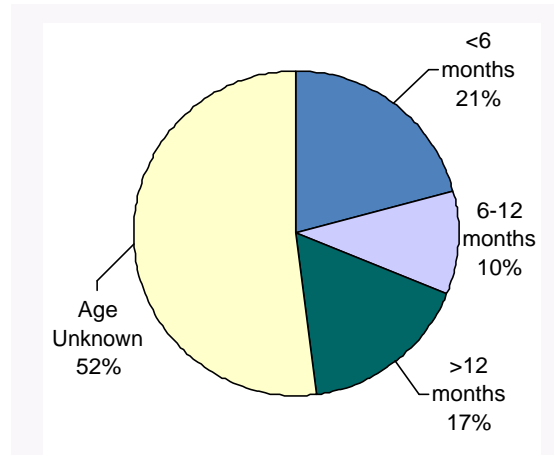
Birth Year	Age at Enrollment									
	<6 months		6-12 months		>12 months		Unknown Age		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
2004	26	48.1	12	22.2	9	16.7	7	13.0	54	29.7
2005	18	51.4	6	17.1	8	22.9	3	8.6	35	24.0
2006	27	35.5	8	10.5	10	13.2	31	40.8	76	45.5
2007	34	34.0	28	28.0	15	15.0	23	23.0	100	51.5
2008	25	49.0	12	23.5	4	7.8	10	19.6	51	32.7
<b>Total</b>	<b>130</b>	<b>41.1</b>	<b>66</b>	<b>20.9</b>	<b>46</b>	<b>14.6</b>	<b>74</b>	<b>23.4</b>	<b>316</b>	<b>37.4</b>



**Figure 9:** Age at enrollment in intervention services for infants diagnosed with permanent hearing loss: Michigan EHDI, 2004-2008.

## Additional Intervention Services

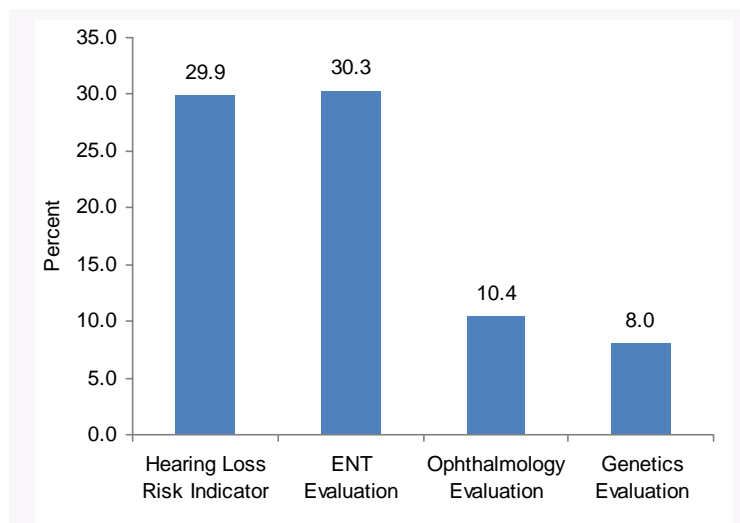
The EHDI Program receives information on amplification devices, cochlear implants, family support programs, as well as medical intervention information including genetics, ENT, and ophthalmology visits for infants with permanent hearing loss. Families may choose which services are appropriate for them and their children. From 2004 to 2008, 37.5% (n=317) of infants with permanent hearing loss had a hearing aid fitting. As shown in Figure 10, of those with a hearing aid fitting from 2004 to 2008, 20.8% (n=66) were fit by 6 months of age, 10.4% (n=33) were fit between 6 and 12 months of age, 16.7% (n=53) were fit after 12 months of age, and 52.1% (n=165) were fit at an unknown age. From 2004 to 2008, 7.7% (n=65) of infants with permanent hearing loss had a cochlear implant.



**Figure 10:** Age at hearing aid fitting for children with permanent hearing loss: Michigan EHDI Intervention Data, 2004-2008.

A variety of support programs and resources are offered to families of children with hearing loss. From 2004 to 2008, 17.3% of families were referred to or enrolled in the Parent Infant Program, 2.4% were referred to or enrolled in Community Mental Health Services, 49.2% were referred or enrolled in Children’s Special Health Care Services (CSHCS), 5.0% were referred to or enrolled in Family-to-Family Support and 8.5% were referred to or enrolled in GBYS. More information about these programs can be found on the EHDI website at: [www.michigan.gov/ehdi](http://www.michigan.gov/ehdi). From 2004 to 2008, 14.1% of families with children with permanent hearing loss received EHDI resource guidebooks which contain information on support programs and state and national resources available to families.

The EHDI Program receives limited medical intervention information on children with hearing loss. Figure 11 shows the percentage of infants with permanent hearing loss with medical interventions from 2004 to 2008. Of those with permanent hearing loss, 29.9% (n=253) had a risk indicator for hearing loss, 30.3% (n=256) had an ENT evaluation, 10.4% (n=88) had an ophthalmology evaluation, and 8.0% (n=68) had a genetic evaluation from 2004 to 2008. These categories are not mutually exclusive and children could have had more than one type of medical intervention. It is important for children with hearing loss to have these evaluations as those with hearing loss may have other medical issues.



**Figure 11:** Medical intervention services for children with permanent hearing loss: Michigan EHDI Intervention Data, 2004-2008.

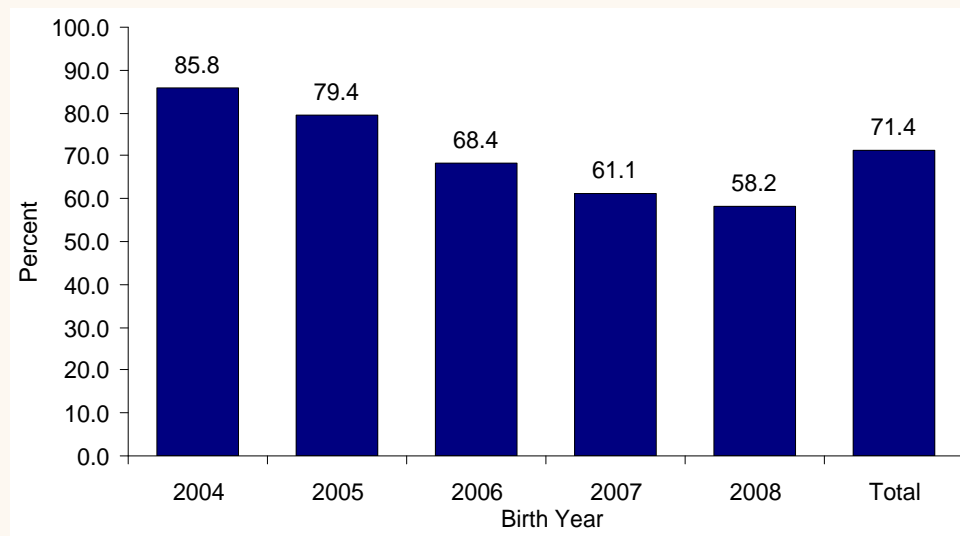
## Loss to Follow-Up

An infant is considered lost to follow-up (LTF) when he or she does not receive appropriate services, or does not have documentation of services, after referring from the final hearing screen. Loss to follow-up is a problem for most EHDI programs across the US with about half of all infants referring from their final screen not receiving appropriate services.<sup>7</sup> Factors that may contribute to high LTF rates include poor communication between EHDI personnel and families, poor data management, lack of facilities, and lack of well-trained personnel.<sup>14</sup> Research has shown that LTF rates were highest among infants of mothers who were non-white, had public insurance, or smoked during pregnancy.<sup>15</sup> LTF rates must be reduced so that all infants receive appropriate and timely care.

Overall in Michigan from 2004 to 2008, 71.4% (n=6,794) of infants referring from the final screen were loss to follow-up. The LTF rate decreased from 85.8% in 2004 to 58.2% in 2008 (Table 11 and Figure 12). The Michigan EHDI Program was awarded a supplemental grant from the Maternal and Child Health Bureau (MCHB) in 2010 to assist in lowering the loss to follow-up rate. EHDI activities related to reducing the loss to follow-up rate are given in the *EHDI Program Highlights* section.

**Table 11:** Loss to follow-up rates: Michigan EHDI, 2004-2008.

Birth Year	Number Referring from Final Screen	Loss to Follow-Up	
		Number	Percent
2004	2,286	1,961	85.8
2005	1,804	1,433	79.4
2006	1,856	1,270	68.4
2007	1,925	1,176	61.1
2008	1,639	954	58.2
<b>Total</b>	<b>9,510</b>	<b>6,794</b>	<b>71.4</b>



**Figure 12:** Loss to follow-up rates: Michigan EHDI, 2004-2008.

LTF rates were analyzed by selected demographic variables including: maternal race, ethnicity, age, and education, and the source of payment for delivery of the baby. The percentage of infants loss to follow-up in each category is shown in Table 12. LTF rates by region of birth place and maternal residence are shown in Appendix E.

Loss to follow-up rates were **highest** among those who:

- Were black, non-Hispanic.
- Were less than 20 years old when they had their baby.
- Had less than a high school education.
- Paid for the delivery of their baby on their own.

Loss to follow-up rates were **lowest** among those who:

- Were Hispanic.
- Were 30 years or older when they had their baby.
- Had some college education or a college degree.
- Had private insurance or some other method to pay for the delivery of their baby.

**Table 12:** Loss to follow-up rates by selected demographic variables: Michigan EHDI, 2004-2008.

Demographic Variable	Number Referring from Final Screen	Loss to Follow-Up	
		Number	Percent
<b>Mom's Race, Ethnicity</b>			
White, Non-Hispanic	4,041	2,742	67.9
Black, Non-Hispanic	3,567	2,894	81.1
Other, Non-Hispanic*	396	262	66.2
Hispanic	1,091	625	57.3
missing	415	271	65.3
<b>Mom's Age</b>			
<20	1,494	1,172	78.4
20-24	2,797	2,090	74.7
25-29	2,428	1,711	70.5
30-34	1,515	988	65.2
35+	903	594	65.8
missing	373	239	64.1
<b>Mom's Education</b>			
<HS	2,844	2,275	80.0
HS diploma/GED	3,246	2,401	74.0
Some College/College degree	2,872	1,757	61.2
missing	548	361	65.9
<b>Source of Payment For Delivery</b>			
Private insurance	4,362	3,033	69.5
Medicaid	4,551	3,363	73.9
Self Pay	124	99	79.8
Other	33	22	66.7
Unknown	63	37	58.7
missing	377	240	63.7

\*Other race category encompasses women who do not define themselves as black or white and includes Native American, Asian/Pacific Islander, etc.

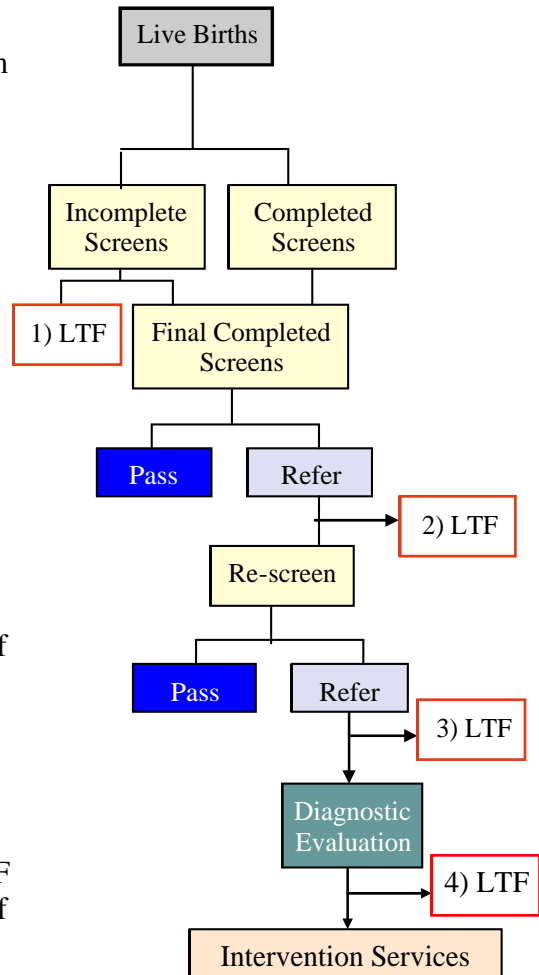
Of note, other ethnicities were not included due to too few cases

## Loss to Follow-Up Stages

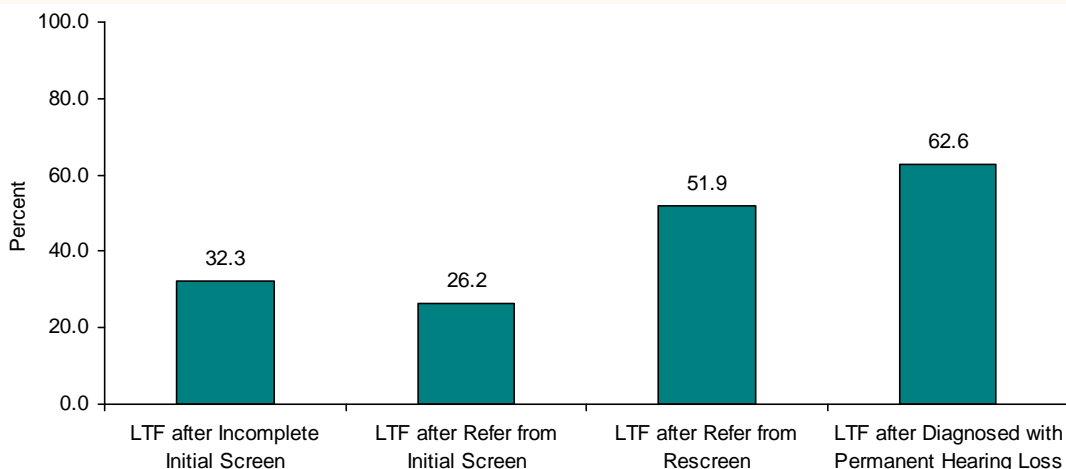
The **overall** LTF rate is defined as the percentage of infants not receiving needed services after referring from the *final* screen. In addition, it is important to analyze LTF rates at multiple stages throughout the EHDI system. Here, LTF rates were assessed at the following stages, as seen in Figure 13:

- 1) When a baby has an incomplete screen but does not have documentation of a subsequent completed hearing screen.
- 2) When a baby refers from the initial screen but does not have documentation of a re-screen to determine if more tests are needed.
- 3) When a baby refers from the re-screen, but does not have documentation of a diagnostic evaluation.
- 4) When a baby is diagnosed with permanent hearing loss but does not have documentation of enrollment in early intervention services.

Overall, from 2004 to 2008, 32.3% of infants with an incomplete screen were LTF; 26.2% of infants referring from the initial screen were LTF; 51.9% of infants referring from the re-screen were LTF; and 62.6% of infants diagnosed with permanent hearing loss were LTF (Figure 14). Parents must be aware of the importance of screening and be encouraged to return for follow-up services. More information on these stages of LTF, including rates by birth place and maternal residence regions, can be found in Appendix E.



**Figure 13:** Four stages of loss to follow-up in the EHDI system.



**Figure 14:** Loss to follow-up rates at three stages of the EHDI system: Michigan EHDI, 2004-2008.

## Michigan vs. National Statistics

The CDC compiles national statistics from state EHDI programs through the ‘CDC EHDI Hearing Screening and Follow-up Survey (HSFS)’. Individual states can use national statistics to assess their achievements in timely detection of hearing loss and enrollment in early intervention services. Here, we compare Michigan with the Nation on the ‘1-3-6’ goals, using data from 2008.

**Table 13:** Michigan vs. National Statistics, 2008.

Indicator	Michigan	Nation*
Percent with complete hospital screen	95.9	96.9
<i>Percent screened no later than 1 month</i>	<i>98.3</i>	<i>92.1</i>
Percent diagnosed after referral from final screen	40.6	46.9
<i>Percent diagnosed no later than 3 months</i>	<i>53.8</i>	<i>68.1</i>
Percent with hearing loss enrolled in EI services	32.7	66.0
<i>Percent enrolled in EI services no later than 6 months</i>	<i>49.0</i>	<i>52.8</i>

*\*National data was obtained from the 2008 National CDC EHDI Hearing Screening & Follow-up Survey<sup>2</sup> and is limited to those states, territories, and districts that respond to the survey.*

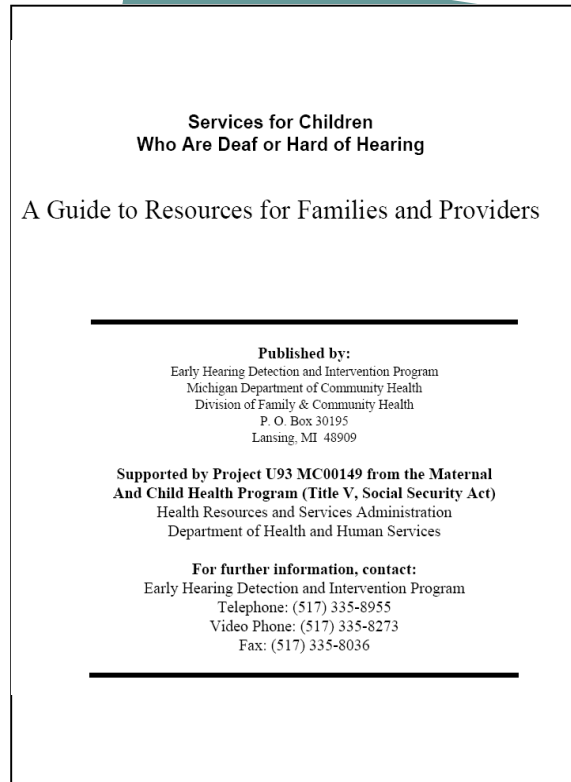
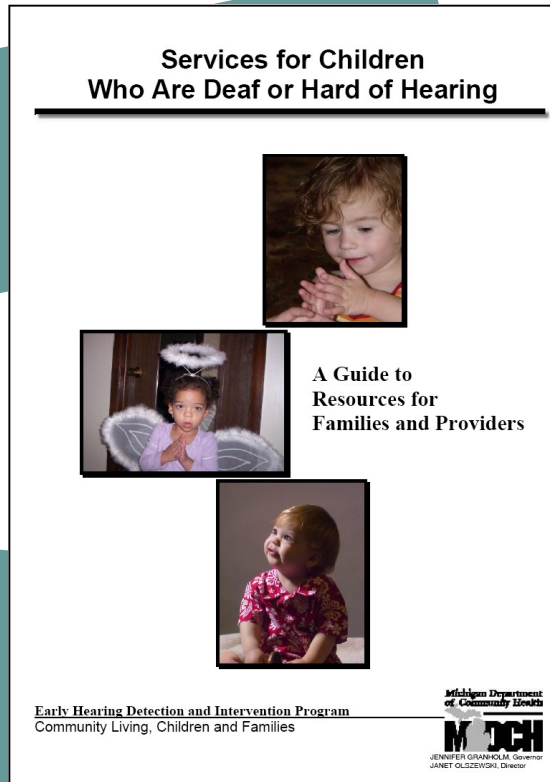
Currently, Michigan is meeting the first national goal with 98.3% of infants screened for hearing loss no later than one month of age in 2008. This compares to the Nation with 92.1% of infants screened no later than one month.

For the second national EHDI goal, in 2008, Michigan had 53.8% of infants who referred from the final screen with a diagnostic evaluation no later than three months of age. This is lower than the Nation which had 68.1% of infants diagnosed no later than three months of age. The percentage of infants diagnosed in Michigan may increase in the future as late reports are received from facilities who do not report diagnostics in a timely manner.

Michigan is slightly lower than the Nation on the third goal of having all infants with permanent hearing loss enrolled in early intervention (EI) services no later than six months of age. Michigan had 49.0% of infants enrolled by six months while the Nation had 52.8% of infants enrolled by six months in 2008. The percentage of infants enrolled in EI services in Michigan may be underestimated due to FERPA regulations that limit EI service personnel from sharing enrollment information with EHDI.

Additional national statistics as well as statistics for other states can be found on the CDC website at: <http://www.cdc.gov/ncbddd/hearingloss/ehdi-data.html>.

# State and National Resources



The 'Guide to Resources for Families and Providers' contains state and national resources on the following topics:

- Advocacy
- Assistive Technology
- Cochlear Implant Centers
- Customer Support
- Deaf-Blind Services
- Early Intervention
- Educational Programs and Services
- Genetic Services
- Hearing Dogs
- Information and Referrals
- Interpreter Services
- Language Assessment
- Mental Health Services
- Parent Networks and Support Organizations
- Professional Associations
- Public Health Services
- Service Clubs
- Speech/Language Therapy
- Vocational Training
- Sibling Support

The resource guide can be found online at:  
[http://www.michigan.gov/documents/a\\_unhsmanual\\_53441\\_7.pdf](http://www.michigan.gov/documents/a_unhsmanual_53441_7.pdf)

or contact the EHDI Program to obtain a copy at:  
(517) 335-8955

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## EHDI Program Highlights

EHDI Program activities revolve around many areas including provider education, data management, family support, and loss to follow-up. Highlighted below are some of the major activities the EHDI Program has been able to accomplish in 2010:

- Offering provider education at multiple conferences in 2010, including:

Michigan Academy of Physician Assistants (MAPA)  
Michigan Chapter of American Academy of Pediatrics (AAP)  
Michigan Academy of Family Physicians (MAOFP)  
Michigan Audiology Conference (MAC)  
Michigan Premier Public Health Conference  
Fall Regional Immunization Conferences in Michigan (4)

- Attending conferences for professional development, exhibiting EHDI displays, and presenting on important EHDI topics including screening, loss to follow-up and early intervention, to promote the EHDI Program and to educate physicians, nurses, and other conference attendees at the following conferences:

Early On Annual Conference  
Michigan Supervisors of Public School Programs for the Hearing Impaired Academy  
Michigan Chapter of American Academy of Pediatrics  
Michigan Otolaryngology Society Annual Conference  
DeVos Pediatric Update Conference  
Michigan Healthy Mothers, Healthy Babies Conference  
National Hands and Voices Leadership Conference  
Michigan Audiology Conference (MAC) - *EHDI partially funded the national speaker*  
National EHDI Conference

- Sponsoring the National Center for Hearing Assessment and Management (NCHAM) Pediatric Audiology Training in Michigan, in February 2010. A total of 45 audiologists attended this training, of which 28 were from Michigan. Training topics included: identification, diagnosis and management of auditory neuropathy; auditory steady state response (ASSR); electrophysiologic diagnosis of hearing loss; hearing aid validation; and cochlear implants in young children.
- Reducing the loss to follow-up (LTF) rate by:
  - Providing mini-grants to eight hospitals to replace aging, broken, or recalled screening equipment.
  - Encouraging best practice methods in quarterly meetings with the two largest birth hospitals in Wayne County.
  - Contacting primary care providers and parents of infants who are LTF.
  - Visiting hospitals around the state to review statistics, improve quality compliance, and promote the online training module and use of the Michigan Hands and Voices “Loss & Found”™ DVD.
  - Surveying families who are lost to follow-up to assess barriers to accessing hearing screens and diagnostic evaluations.



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- Providing EHDI updates, highlights, and educating physicians, nurses and audiologists through: the quarterly EHDI newsletter (for birth hospitals); the Michigan Audio-gram (newsletter for audiologists); two radio interviews at WJLB to promote follow-up; public service announcements airing in February and March, 2010 in the Metro-Detroit area to promote follow-up.
  - Contributing to Hands and Voices and Guide By Your Side (GBYS) through the following activities:
    - Participating in the Michigan Hands and Voices picnic for families in the program.
    - Collaborating with six other states to produce the DVD, “Loss & Found”™, to promote follow-up.
    - Providing two GBYS trainings a year for the parent guides. Attendance at the Michigan EHDI Conference 2010 was required, which focused on minimal and unilateral hearing loss. The fall training was on facilitating the grief process.
    - Producing new and revised brochures and documents for the programs.
    - Working together with ten guides throughout Michigan who make home visits to families with children diagnosed with hearing loss.
    - Publishing a quarterly Michigan Hands and Voices Newsletter
  - Enhancing hearing screen and diagnostic results to physicians and nurses by displaying results on the Michigan Care Improvement Registry (MCIR), and creating a document detailing follow-up action steps for all screening results.
  - Establishing guidelines for “Otolaryngologic Evaluation of Infants with Hearing Loss” and distributing to otolaryngologists (ENTs), pediatricians and primary care physicians. The purpose of the document is to educate providers on EHDI Program goals and to provide guidance for ENT evaluation that is consistent with the Joint Committee Infant Hearing (JCIH) 2007 guidelines.
  - Establishing best practice guidelines for screening and diagnostic evaluation by audiologists in the state of Michigan. The guidelines helped to update the list of audiologists in Michigan.
  - Surveying families of children who are diagnosed with hearing loss to assess EHDI processes and reactions to failed screenings and diagnoses to help improve the EHDI Program.
  - Meeting with the EHDI Advisory Committee four times per year, collaborating with audiologists, primary care providers, otolaryngologists, birthing hospital EHDI liaisons, parents of children with hearing loss, representatives from early intervention programs, Children’s Special Health Care Services (CSHCS), and others. The EHDI Advisory members may participate in the Diagnostic, Early Intervention, or Provider Education Subcommittees.
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# Appendices

## A. Risk Factors for Hearing Loss

## B. Hearing Loss Diagnoses Reportable to EHDI

**Table 1:** Permanent hearing loss reportable to EHDI.

**Table 2:** Non-permanent hearing loss and other conditions reportable to EHDI.

## C. EHDI Evaluation Plan

**Table 1:** EHDI Evaluation Plan.

## D. Permanent Hearing Loss by Result of the Final Screen

**Table 1:** Prevalence of permanent hearing loss by result of final screen.

## E. Loss to Follow-Up (LTF) Rates

**Figure 1:** Geographic regions approximate pediatric specialty care service areas.

**Table 1:** Infants LTF after referring from the final screen by birth and maternal residence regions in Michigan.

**Table 2:** LTF rates by EHDI stages and by selected demographic variables.

**Table 3:** LTF rates by EHDI stages and by birth and maternal residence region in Michigan.

**Table 4:** LTF from diagnosis of permanent hearing loss to enrollment in early intervention services by maternal residence region.

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## Appendix A

### Risk Factors for Hearing Loss

The Joint Committee on Infant Hearing, Year 2007 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs ([www.jcih.org](http://www.jcih.org)) recommended the 11 risk indicators listed below that are associated with either congenital or delayed-onset hearing loss. All infants with a risk indicator for hearing loss should be referred for an audiological assessment at least once by 24 to 30 months of age. Children with risk indicators that are highly associated with delayed-onset hearing loss, such as having received ECMO or having CMV infection, should have more frequent audiological assessments.

Risk indicators associated with congenital, delayed-onset, or progressive hearing loss in childhood are listed below. Risk indicators that are marked with an asterisk\* are of greater concern for delayed-onset hearing loss.

1. Caregiver concern\* regarding hearing, speech, language or developmental delay.
2. Family history\* of permanent childhood hearing loss.
3. Neonatal intensive care of more than 5 days or any of the following regardless of length of stay: ECMO (extracorporeal membrane oxygenation)\*, assisted ventilation, exposure to ototoxic medications (gentamicin and tobramycin) or loop diuretics (furosemide/Lasix), and hyperbilirubinemia that requires exchange transfusion.
4. In utero infections, such as CMV (cytomegalovirus)\*, herpes, rubella, syphilis and toxoplasmosis.
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

**Table 1:** Permanent hearing loss reportable to the Michigan Early Hearing Detection and Intervention Program.

Permanent Hearing Loss	
Diagnostic Code	Meaning
AN	Auditory Neuropathy
BSNMILD	Bilateral sensorineural mild
BSNMOD	Bilateral sensorineural moderate
BSNSEV	Bilateral sensorineural severe
BSNPRO	Bilateral sensorineural profound
RUSNMILD	Right unilateral sensorineural mild
RUSNMOD	Right unilateral sensorineural moderate
RUSNSEV	Right unilateral sensorineural severe
RUSNPRO	Right unilateral sensorineural profound
LUSNMILD	Left unilateral sensorineural mild
LUSNMOD	Left unilateral sensorineural moderate
LUSNSEV	Left unilateral sensorineural severe
LUSNPRO	Left unilateral sensorineural profound
BMIXMOD	Bilateral mixed moderate
BMIXSEV	Bilateral mixed severe
BMIXPRO	Bilateral mixed profound
RUMIXMOD	Right unilateral mixed moderate
RUMIXSEV	Right unilateral mixed severe
RUMIXPRO	Right unilateral mixed profound
LUMIXMOD	Left unilateral mixed moderate
LUMIXSEV	Left unilateral mixed severe
LUMIXPRO	Left unilateral mixed profound
BCONDPRMNTMILD	Bilateral conductive permanent mild
BCONDPRMNTMOD	Bilateral conductive permanent moderate
BCONDPRMNTSEV	Bilateral conductive permanent severe
RUCONDPRMNTMILD	Right unilateral conductive permanent mild
RUCONDPRMNTMOD	Right unilateral conductive permanent moderate
RUCONDPRMNTSEV	Right unilateral conductive permanent severe
LUCONDPRMNTMILD	Left unilateral conductive permanent mild
LUCONDPRMNTMOD	Left unilateral conductive permanent moderate
LUCONDPRMNTSEV	Left unilateral conductive permanent severe

**Table 2:** Non-permanent hearing loss and other conditions reportable to the Michigan Early Hearing Detection and Intervention Program.

<b>Non-Permanent Hearing Loss</b>	
<b>Diagnostic Code</b>	<b>Meaning</b>
BCONDMILD	Bilateral conductive mild
BCONDMOD	Bilateral conductive moderate
RUCONDMILD	Right unilateral conductive mild
RUCONDMOD	Right unilateral conductive moderate
LUCONDMILD	Left unilateral conductive mild
LUCONDMOD	Left unilateral conductive moderate
BCONDTRANSMILD	Bilateral conductive transient mild
BCONDTRANSMOD	Bilateral conductive transient moderate
BCONDTRANSSEV	Bilateral conductive transient severe
RUCONDTRANSMILD	Right unilateral conductive transient mild
RUCONDTRANSMOD	Right unilateral conductive transient moderate
RUCONDTRANSSEV	Right unilateral conductive transient severe
LUCONDTRANSMILD	Left unilateral conductive transient mild
LUCONDTRANSMOD	Left unilateral conductive transient moderate
LUCONDTRANSSEV	Left unilateral conductive transient severe
<b>Other</b>	
<b>Diagnostic Code</b>	<b>Meaning</b>
WNL	Within normal limits bilaterally, determined via diagnostic ABR
UNDETERMINED	Left or right ear result is undetermined or blank

## Appendix C

**Table 1:** Michigan EHDI Evaluation Plan.

Evaluation Plan	Develop Evaluation Plan to Support EHDI Tracking and Surveillance	
	Activities and Descriptions	Evaluation
<b>Objective #1:</b> Ensure that national data needs (DSHPSHWA) are reported.	Run query report and analyze reports for ways to improve follow-up.	Query data and report results annually
<b>Objective #2:</b> Provide feedback to stakeholders on EHDI state progress in an annual report.	Complete an annual report	Annual written product.
	Disseminate to stakeholders (physicians, hospitals, audiologists and legislators, advisory members).	Annual written product.
	Post on EHDI web page.	Date placed on EHDI web page.
<b>Objective #3:</b> Perform at least three data quality assurance control activities.	Continue with quarterly statistical reports and newsletter to hospitals.	Written product.
	Continue with monthly hospital verification of missing and incomplete cases.	# of newborns who are missed and incomplete.
	Implement 5% weekly scanning verification protocol.	# of records verified per week and % correct.
	Implement 10% weekly re-screening entry verification protocol.	# of records verified per week and % correct.
	Review and update all Verification protocols.	Annual review and update.
	Continue with HIPAA Training	Certificate of Completion.

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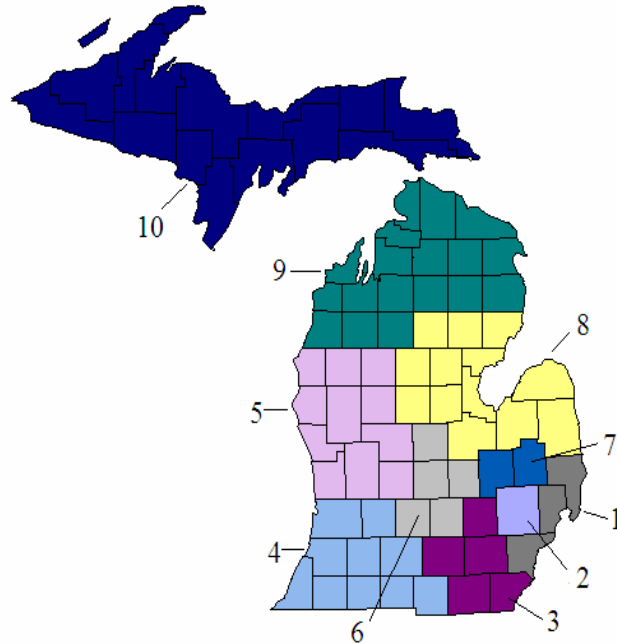
## Appendix D

**Table 1:** Prevalence of permanent hearing loss by result of final screen: Michigan EHDI, 2004-2008.

Birth Year	Final Screen Result		Permanent Hearing Loss	
	Result	Number	Number	Rate (per 1,000 live births)
2004	Pass	117,781	69	0.5
	Fail	2,286	100	0.8
	Incomplete	1,789	13	0.1
	<b>Total Screened</b>	<b>121,856</b>	<b>182</b>	<b>1.4</b>
2005	Pass	120,224	47	0.4
	Fail	1,804	92	0.7
	Incomplete	1,225	7	0.1
	<b>Total Screened</b>	<b>123,253</b>	<b>146</b>	<b>1.1</b>
2006	Pass	120,644	45	0.4
	Fail	1,856	108	0.8
	Incomplete	1,263	14	0.1
	<b>Total Screened</b>	<b>123,763</b>	<b>167</b>	<b>1.3</b>
2007	Pass	118,393	38	0.3
	Fail	1,925	132	1.1
	Incomplete	1,231	24	0.2
	<b>Total Screened</b>	<b>121,549</b>	<b>194</b>	<b>1.5</b>
2008	Pass	114,642	20	0.2
	Fail	1,639	129	1.1
	Incomplete	1,174	7	0.1
	<b>Total Screened</b>	<b>117,455</b>	<b>156</b>	<b>1.3</b>
2004-2008	Pass	591,684	219	0.3
	Fail	9,510	561	0.9
	Incomplete	6,682	65	0.1
	<b>Total Screened</b>	<b>607,876</b>	<b>845</b>	<b>1.3</b>



## Appendix E



**Figure 1:** Geographic regions approximate pediatric specialty care service areas.

<p><b>Region 1</b> Macomb St. Clair Wayne</p>	<p><b>Region 5</b> Ionia Kent Lake Mason Mecosta Montcalm Muskegon Newaygo Oceana Osceola Ottawa</p>	<p><b>Region 8</b> Arenac Bay Clare Gladwin Huron Iosco Isabella Midland Ogemaw Roscommon Saginaw Sanilac Tuscola</p>	<p>Leelanau Manistee Missaukee Montmorency Oscoda Otsego Presque Isle Wexford</p>
<p><b>Region 2</b> Oakland</p>	<p><b>Region 6</b> Clinton Eaton Gratiot Ingham Shiawassee</p>	<p><b>Region 9</b> Alcona Alpena Antrim Benzie Cheboygan Charlevoix Crawford Emmet Grand Traverse Kalkaska</p>	<p><b>Region 10</b> Alger Baraga Chippewa Delta Dickinson Gogebic Houghton Iron Keweenaw Luce Mackinac Marquette Menominee Ontonagon Schoolcraft</p>
<p><b>Region 3</b> Jackson Lenawee Livingston Monroe Washtenaw</p>	<p><b>Region 7</b> Genesee Lapeer</p>		
<p><b>Region 4</b> Allegan Barry Berrien Branch Calhoun Cass Hillsdale Kalamazoo St. Joseph Van Buren</p>			

**Table 1:** Infants loss to follow-up (LTF) after referring from the final screen by birth and maternal residence regions in Michigan: Michigan EHDI, 2004-2008.

Region	Number Referring from Final Screen	Loss to Follow-Up	
		Number	Percent
<b>State of Michigan</b>	<b>9,510</b>	<b>6,794</b>	<b>71</b>
<b>Birth Place Region</b>			
Region 1	1,622	1,216	75.0
Region 2	291	133	45.7
Region 3	246	136	55.3
Region 4	189	117	61.9
Region 5	322	166	51.6
Region 6	90	46	51.1
Region 7	182	99	54.4
Region 8	371	97	26.1
Region 9	68	28	41.2
Region 10	24	14	58.3
<i>Missing Region Information</i>	<i>6,105</i>	<i>4,742</i>	
<b>Maternal Residence Region</b>			
Region 1	4,909	4,045	82.4
Region 2	577	329	57.0
Region 3	571	410	71.8
Region 4	607	429	70.7
Region 5	749	485	64.8
Region 6	245	164	66.9
Region 7	312	191	61.2
Region 8	879	315	35.8
Region 9	199	127	63.8
Region 10	81	55	67.9
<i>Missing Region Information</i>	<i>381</i>	<i>244</i>	

**Table 2:** Loss to follow-up (LTF) rates by EHDI stages and by selected demographic variables, Michigan EHDI, 2004-2008.

Demographic Variable	LTF after Incomplete Initial Screen		LTF after Refer from Initial Screen		LTF after Refer from Rescreen				
	Number with Incomplete Screen	LTF		Number Referring from Initial Screen	LTF				
		Number	Percent		Number	Percent	Number	Percent	
<b>Birth Year</b>									
2004	2,913	1,451	49.8	4,361	1,754	40.2	321	208	64.8
2005	2,687	805	30.0	4,468	1,265	28.3	274	168	61.3
2006	2,745	696	25.4	4,416	1,095	24.8	335	175	52.2
2007	2,748	723	26.3	4,840	1,033	21.3	347	143	41.2
2008	2,388	682	28.6	4,708	822	17.5	316	132	41.8
<b>Total</b>	<b>13,481</b>	<b>4,357</b>	<b>32.3</b>	<b>22,793</b>	<b>5,969</b>	<b>26.2</b>	<b>1,593</b>	<b>826</b>	<b>51.9</b>
<b>Mom's Race, Ethnicity</b>									
White, Non-Hispanic	6,515	2,053	31.5	11,108	2,307	20.8	840	436	51.9
Black, Non-Hispanic	3,041	1,150	37.8	6,374	2,693	42.2	349	201	57.6
Other, Non-Hispanic	478	157	32.8	953	234	24.6	54	28	51.9
Hispanic	2,152	570	26.5	3,588	503	14.0	273	122	44.7
Missing	1,295	427	33.0	770	232	30.1	77	39	50.6
<b>Mom's Age</b>									
<20	1,331	529	39.7	2,997	1,054	35.2	187	118	63.1
20-24	3,169	1,131	35.7	6,401	1,854	29.0	442	236	53.4
25-29	3,339	1,014	30.4	6,156	1,505	24.4	407	206	50.6
30-34	2,665	799	30.0	4,155	861	20.7	280	128	45.7
>34	1,765	487	27.6	2,409	491	20.4	207	103	49.8
Missing	1,212	397	32.8	675	204	30.2	70	35	50.0
<b>Mom's Education</b>									
<HS	2,717	993	36.5	5,387	2,058	38.2	366	217	59.3
HS diploma/GED	3,910	1,345	34.4	7,566	2,120	28.0	526	281	53.4
Some College/College Degree	5,398	1,521	28.2	8,773	1,474	16.8	611	284	46.5
Missing	1,456	498	34.2	1,067	317	29.7	90	44	48.9
<b>Source of Payment for Delivery</b>									
Private Insurance	6,396	1,883	29.4	11,167	2,664	23.9	754	370	49.1
Medicaid	5,111	1,865	36.5	10,489	2,956	28.2	734	407	55.4
Self Pay	516	142	27.5	218	93	42.7	15	6	40.0
Other	13	<5		69	19	27.5	5	<5	
Unknown	223	64	28.7	166	33	19.9	13	<5	
Missing	1,222	399	32.7	684	204	29.8	72	36	50.0

\*Other race category encompasses women who do not define themselves as black or white and includes Native American, Asian/Pacific Islander, etc. Of note, other ethnicities were not included due to too few cases

**Table 3: Loss to follow-up rates (LTF) by EHDI stages and by birth and maternal residence region in Michigan: Michigan EHDI, 2004-2008.**

Region	LTF after Incomplete Initial Screen		LTF after Refer from Initial Screen		LTF after Refer from Rescreen		
	Number with an Incomplete Screen	LTF	Number Referring from Initial Screen	LTF	Number Referring from Re-Screen	LTF	
State of Michigan	13,481	32.3	22,793	5,969	1,593	826	51.9
<b>Birth Place Region</b>							
Region 1	1,501	31.1	3,671	1,105	214	111	51.9
Region 2	225	26.7	839	108	63	25	39.7
Region 3	554	28.2	709	117	50	19	38.0
Region 4	362	28.2	660	89	60	28	46.7
Region 5	583	20.8	1,256	131	94	35	37.2
Region 6	385	19.7	468	35	37	11	29.7
Region 7	219	26.5	508	87	41	12	29.3
Region 8	284	22.2	614	93	32	<5	
Region 9	189	24.9	388	19	24	9	37.5
Region 10	113	36.3	136	7	12	7	58.3
<i>Missing Region Information</i>	9,066	34.9	13,544	4,178	966	565	58.5
<b>Maternal Residence Region</b>							
Region 1	3,810	40.4	9,877	3,736	532	309	58.1
Region 2	700	34.1	1,587	287	105	42	40.0
Region 3	1,515	37.6	1,709	356	100	54	54.0
Region 4	1,118	32.0	1,842	340	167	89	53.3
Region 5	1,528	20.2	2,624	348	261	137	52.5
Region 6	1,346	25.8	860	118	78	46	59.0
Region 7	535	24.5	831	154	80	38	47.5
Region 8	732	27.3	1,605	275	127	40	31.5
Region 9	614	20.7	819	103	50	24	48.0
Region 10	326	39.0	347	44	21	11	52.4
<i>Missing Region Information</i>	1,257	45.2	692	208	72	36	50.0

**Table 4:** Loss to follow-up (LTF) from diagnosis of permanent hearing loss to enrollment in early intervention services by maternal residence region: Michigan EHDI Intervention Data, 2004-2008.

Region	LTF after Diagnostic Evaluation		
	Number with Permanent Hearing Loss	LTF	
		Number	Percent
<b>State of Michigan</b>	<b>845</b>	<b>529</b>	<b>62.6</b>
Region 1	218	142	65.1
Region 2	103	62	60.2
Region 3	74	49	66.2
Region 4	83	57	68.7
Region 5	143	70	49.0
Region 6	40	26	65.0
Region 7	43	20	46.5
Region 8	67	48	71.6
Region 9	20	13	65.0
Region 10	20	10	50.0
<i>Missing Region Information</i>	34	32	94.1