

# MICHIGAN EARLY HEARING DETECTION AND INTERVENTION (EHDI) PROGRAM

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OUT-OF-HOSPITAL BIRTH STUDY  
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## ABSTRACT

**Purpose:** To evaluate the demographic characteristics of the out-of-hospital birth population, the proportion of out-of-hospital births receiving adequate screening for hearing loss, and the number of cases of diagnosed hearing loss in the out-of-hospital birth population.

**Methods:** This is a retrospective cohort study for quality improvement purposes. Michigan Birth Defects Registry (MBDR) records, provided by the State of Michigan Division of Vital Records and Health Statistics for births between January 1, 2014 and December 31, 2016, were linked with Newborn Screening (NBS) records. Analyses were conducted to evaluate the demographics of the out-of-hospital birth population, the hearing screen submission rates, and the diagnoses of hearing loss in the out-of-hospital birth population. Separate analyses were completed for all out-of-hospital births and midwife attended out-of-hospital births only.

**Results:** There were 3,333 infants in the total out-of-hospital birth population, with 2,205 infants in the midwife assisted birth population. Of the 3,333 infant births in the out-of-hospital birth population, 90.1% had mothers who were white, 95.9% had mothers who elected to use prenatal care, 48.8% had prenatal care initiated in the first trimester, and 58.5% of the infants had mothers with a college degree. In the midwife attended out-of-hospital birth population, 90.6% of infants were white, 99.5% of mothers elected to use prenatal care, 48.5% of mothers initiated prenatal care in the first trimester, 55.1% of mothers had less than a college education, and the largest proportion of mothers (33.2%) were between the ages of 25 and 29. Of the births attended by midwives that had a Newborn Screening (NBS) record, 47.9% of mothers refused the hearing screen. Of all births attended by midwives, 10.7% of the infants had only Michigan Birth Defects Registry (MBDR) records and not NBS records. There were four individuals with hearing loss diagnoses on both NBS and MBDR records, two with a diagnosis on only NBS records, and two with a diagnosis on only MBDR records.

**Conclusion:** The refusal rate for the non-invasive hearing screening was high in the out-of-hospital birthing community, both overall and in births attended by midwives. Furthermore, diagnoses are discrepant between NBS and MBDR records. Further examination of these findings in future studies may prove beneficial into increasing the hearing screen rates and the quality of data being obtained.

**Key Words:** EHDI, Out-of-hospital birth, Hearing Screening

## INTRODUCTION

Annually, there are roughly 1,500 babies born in Michigan that are reported as non-hospital births. As per the 1-3-6 hearing screening goals set by the Early Hearing Detection and Intervention (EHDI) Program at the Michigan Department of Health and Human Services (MDHHS), the goal is to have a hearing screening test completed and submitted within one month of birth for every newborn. The homebirth community had not, until this point, been adequately studied with regards to hearing screening practices, screening rates, demographics, or diagnoses. This study was designed to address these areas and to determine if further intervention is needed to increase compliance with standards set by MDHHS. This study aimed to assess the demographics of the out-of-hospital birth community, the hearing screen submission rates of midwives who are assisting in out-of-hospital births, and whether NBS and MBDR records corroborate with regards to hearing loss diagnoses.

## METHODS

This was a retrospective cohort study examining the out-of-hospital birth population in the State of Michigan. Birth record data from the State of Michigan Division of Vital Records and Health Statistics was received for all non-hospital births between January 1, 2014 and December 31, 2016. Records included birth attendant, demographic factors related to the mother, birth hospital, any infections of the mother or child, any congenital anomalies of the child, and master record number for linking. Birth defects records from the State of Michigan Birth Defects Registry (MBDR) were also received for these individuals. Birth records and MBDR records were linked via master record number. Any ICD-9 or ICD-10 codes pertaining to infant hearing loss, birth hospital, and the master record number were requested from the MBDR. The birth records and MBDR records were joined by matching on master record number. These babies were then joined with records from the Newborn Screening (NBS) Program via probabilistic matching to obtain any available hearing screening data on these children.<sup>1</sup>

Data were analyzed using SAS statistical software<sup>2</sup>. The three data sources were linked in SAS and any births that did not have an attendant, was attended by an emergency medical services employee, or had an attendant whose name in full or part was recorded as “unknown” were removed from the data set. The resulting data set was analyzed to look at demographic factors of the mother and child, perinatal characteristics, screening results, and diagnostic results. Diagnostic results included only permanent hearing loss. A subset of this data set was constructed to look only at attendants who attended five or more births during the study period. This subset was used to obtain the total number of births attended by each midwife, number of attempted screens including refused screens, and the number of screens conducted and submitted. The second subset of individuals included any out of hospital births that had their blood spot screen taken at a hospital. The screening rates among this subset were examined to see if these babies were receiving hearing screens in nurseries after they received their blood spot screen. If the individual did not receive a hearing screen, the hospital at which the screening did not take place was noted. This quality improvement analysis was done to evaluate whether babies were being sent to the nursery for hearing screens.

## RESULTS

### Overall Population

#### Demographics

The total out-of-hospital birth population included 3,333 infants born between January 1, 2014 and December 31, 2016. Among the mothers in the out-of-hospital birth population, 91.7% were found to be white, 7.5% were black, and 0.9% were of other races (Table 1). The breakdown of race of the child was slightly different when comparing birth records and NBS records due to NBS records having Hispanic as its own racial ethnic group. On birth certificate records, 90.1% of children were white, 8.7% were black, and 1.1% were other races. The NBS records showed 83.1% of the infants to be non-Hispanic white, 7.4% to be non-Hispanic black, 4.1% to be Hispanic, and 5.4% to be other races and not of Hispanic ethnicity.

Most of the mothers in the out-of-hospital birth population did not have any type of college degree (58.5%) at the time of birth of their child. Prenatal care was elected to be used in 95.9% of the out-of-hospital birth population and was most commonly initiated in the first trimester (48.8%). Of all mothers in the out-of-hospital birth population, 37.6% initiated prenatal care in the second trimester, while 9.4%

initiated prenatal care in the third trimester. In the out-of-hospital birth population, most mothers were between the ages of 26 and 30 (32.5%), followed by ages 31 to 35 (31.3%), with a mean age of 29.76 years.

#### Diagnostics

Of the 3,333 out-of-hospital births, 2,975 (89.3%) individuals had NBS records submitted and 1,734 (52.0%) of these infants passed their final administered hearing screen (Table 2). There were 35 (1.1%) infants that failed their final hearing screen. Of the 3,333 out-of-hospital births, 1,179 (35.4%) had refused a hearing screen, while 27 (0.8%) infants were not screened for other reasons including equipment failure. Sixteen babies were diagnosed with hearing loss based on the following: five babies who had a hearing loss diagnosis on only NBS records, five babies who had a hearing loss diagnosis on both NBS records and MBDR records, and six babies who had a hearing loss diagnosis on only MBDR records (Table 3). Of the six babies who were diagnosed with hearing loss on only MBDR records, all received hearing screens and two failed their screen. All babies who had a hearing loss diagnosis on NBS records, regardless of diagnosis status on MBDR records, failed their hearing screen or were not administered a hearing screen but were later diagnosed with hearing loss.

A brief analysis looked at a subpopulation of babies who were out-of-hospital births but were then taken to hospitals for newborn screening tests to be completed. Hospitals submitted blood spot screens on 689 out-of-hospital births. Of these 689 births, 34 (4.9%) babies from 25 different hospitals did not have a hearing screen reported to NBS (data not shown). Of these 34 babies, 13 had blood spot submitted in the neonatal intensive care unit. This information shows which hospitals are not properly sending out-of-hospital births to the nursery for hearing screening to be completed once they are brought to the hospital, but this does not account for the reason the screens are not taking place.

### Midwife Attended Births

#### Demographics

The demographics of the out-of-hospital birth population attended by midwives that attended five or more births were very similar to the overall population (Table 1). Of mothers in the midwife attended birth population, 92.0% were white, 7.3% were black, and 0.7% were other races. When compared to the overall out-of-hospital birth population, similar racial/ethnic discrepancies by data source were observed within this group as well.

Most mothers in the midwife assisted out-of-hospital birth subpopulation elected to use prenatal care (99.5%) and initiated prenatal care in the first trimester (48.5%). Prenatal care was initiated by mothers in the second trimester 40.9% of the time, and in the third trimester 10.1% of the time. Of the mothers who had births assisted by midwives, 55.1% did not have a college degree at the time of birth. Most of the mothers were between ages 25 and 29 (33.2%), followed by 30 to 34 (32.1%).

#### Diagnostics

Of the 2,469 midwife attended births, 2,205 (89.7%) had NBS records submitted to the State of Michigan, with 1,111 (45%) infants passing their final hearing screen (Table 2). Mothers refused hearing screens in 1,055 (42.7%) of the births. Screening records showed that there were 24 total infants that failed their final hearing screen in the midwife assisted population and 15 infants were not screened for reasons other than refusal. Eight babies were diagnosed with hearing loss based on the following: four babies were diagnosed with hearing loss on both MBDR and NBS records who all failed their

administered hearing screen, two babies were diagnosed with hearing loss on only NBS records, one baby failed their screen and one baby who was not screened, and two babies diagnosed with hearing loss on only MBDR records who passed both of their hearing screens (Table 3).

### Midwife Screening Rates

There were 69 midwife attendants who attended five or more births in the study period with a range of five births to 195 births being attended (data not shown). Midwives attended a total of 2,469 infant births in the study period. Of these births, 2,205 (89.3%) had NBS records, specifically blood spot cards, reported to NBS (Table 4). Hearing screen results were reported for 1,135 (51.5%) of the 2,205 babies with NBS records. Mothers refused hearing screening for their infant in 1,055 (47.8%) births of the 2,205 births with NBS records.

There were 57 midwives (82.6%), out of the 69 total, that submitted blood spot screens on greater than 75% of births that they attended. Almost one third (31.9%) of the midwives submitted blood spot screens on every birth attended. Hearing screen submission rates were lower, as 22 (31.9%) midwives submitted screens on less than 25% of births attended. Only 37.7% of midwives submitted hearing screening results on more than 75% of births attended.

## DISCUSSION

The out-of-hospital birth population was very similar to the subpopulation of out-of-hospital births attended by midwives. Both populations were predominantly white, had mothers who had less than a college education, elected to use prenatal care, initiated prenatal care in the first trimester, and were between the ages of 25 and 29 years old. A larger proportion of mothers chose not to use prenatal care in the overall population as compared to the midwife assisted birth subpopulation. Another difference between the two populations was with the percent of hearing screens being refused. Proportionately, more mothers refused hearing screens in the midwife assisted birth subpopulation than in the out-of-hospital birth population overall. Despite the difference in the proportion of hearing screens being refused between the two populations, it is alarming to see that over one-third of parents of out-of-hospital births are refusing to have their newborn screened for hearing loss. As this hearing screen is a non-invasive screen, further consideration should be taken to investigate the reasons contributing to the high refusal rate.

The Michigan EHDl Program expects for between one and three infants per 1,000 births to be affected by hearing loss. There were eight babies diagnosed with hearing loss in the 2,469 midwife-attended homebirths, or 3.24 diagnoses per 1,000 births. In the overall out-of-hospital birth population, there were 16 diagnoses in the 3,333 birth, or 4.8 hearing loss diagnoses per 1,000 births. Both values were higher than expected. When examining only hearing loss diagnoses on NBS records, there were 2.43 diagnoses per 1,000 midwife-attended births and 3.0 diagnoses per 1,000 out-of-hospital births. Half of the babies with a hearing screen diagnosis in the midwife-assisted birth subpopulation had a hearing loss diagnosis on both NBS records and MBDR records. The remaining four babies were split with two having a hearing loss diagnosis on MBDR records only and two having a hearing loss diagnosis on NBS records only. This is an intriguing statistic that will require future investigation, as NBS records should corroborate with MBDR records, although the MBDR is a passive registry. These findings are even more apparent when the overall out-of-hospital birth population is examined. Less than half (31.3%) of the individuals with a hearing loss diagnosis (n=5) have a diagnosis listed on both NBS and MBDR records.

There were five individuals with a diagnosis listed on only NBS records, and six individuals with diagnoses listed on only MBDR records. In the future, it may be beneficial to examine these individuals to examine why their diagnosis status appeared in one data source but not the other.

Most midwives submitted blood spot screens on greater than 90% of births attended. Blood spot submission rates were high, but the rates of submission of hearing screen results were much lower as just over one third of midwives in this population submitted hearing screen results on greater than 75% of the births attended. One out of every ten midwives did not submit hearing screening results on any births attended. Just under half of the midwives submitted data on half of the births that they attended or less. These screening rates are quite low, and it will be important to investigate further the reasons related to babies having blood spot screens submitted, but not having any hearing screen results submitted. The marked drop in screening rates between blood spot screening and hearing screening is interesting as blood spot screening is an invasive screen requiring a heel prick, while hearing screening is non-invasive. Examination of potential barriers to screening may prove to be beneficial in increasing hearing screen results submission rates in the future. Access to screening equipment may be a barrier for midwives conducting hearing screens. Screening equipment is expensive and not all midwives have direct access to the equipment. Further input from midwives, potentially using surveys, could help to identify the barriers to screening.

There are some limitations to this study that should be considered. First, the study population is out-of-hospital births in the State of Michigan. This population is not necessarily generalizable to the general population of the United States. Michigan does not currently use an active MBDR and so another limitation with this study is that the MBDR is a passive registry. Cases and diagnoses are only present in the registry when they are reported to it. Reporting for the MBDR may be done up until two years of age and so there is a possibility that some infants born in the second half of 2016 may have diagnoses added to their MBDR records in the future. A final limitation of this study is that it suggests that there is a high rate of refusal of hearing screens in the out-of-hospital population, but reasons for the low reporting rates are not examined. This is one of the first studies to look at the combination of demographics of the out-of-hospital birth population, the hearing screen reporting rates of midwives, and the comparison of NBS and MBDR databases with regards to hearing loss diagnoses. There is the potential for future studies to further examine the factors related to hearing screen refusals in the out-of-hospital birth population.

## CONCLUSION

Overall, midwives are obtaining blood spot screens for over 90% of infant births attended, but just over half of these births have hearing screen results submitted. The rate of refusal of hearing screens was high as 42.7% of parents refused a hearing screen for their child. This is a troubling statistic that needs to be further examined as to why parents are refusing a non-invasive screen. Although not all hearing loss is birth defects-related, a troubling piece of information obtained through these analyses was that the NBS and MBDR diagnoses only corroborated around half of the time. Further examination into why there were infants diagnosed with hearing loss on one source of data but not the other may be worth exploring.

Table 1: Demographics of Out-of-Hospital Births in Michigan from 2014-2016\*

| Variable                              | Attended by Midwives<br>(N = 2,469 Births) |             | All Births<br>(N = 3,333 Births) |             |
|---------------------------------------|--|-------------|----------------------------------|-------------|
|                                       | Frequency (N)                              | Percent (%) | Frequency (N)                    | Percent (%) |
| <b>Maternal Race<sup>1</sup></b>      |  |             |                                  |             |
| Other                                 | 17   | 0.7         | 29                               | 0.9         |
| Black                                 | 176  | 7.3         | 243                              | 7.5         |
| White                                 | 2,222                                      | 92.0        | 2,988                            | 91.7        |
| <b>Child Race (EBC)<sup>2</sup></b>   |  |             |                                  |             |
| White                                 | 2,069                                      | 90.6        | 2,786                            | 90.1        |
| Black                                 | 193  | 8.5         | 270                              | 8.7         |
| Other                                 | 21   | 0.9         | 35                               | 1.1         |
| <b>Child Race (NBS)</b>               |  |             |                                  |             |
| White                                 | 1,823                                      | 83.1        | 2,421                            | 83.1        |
| Black                                 | 154  | 7.0         | 215                              | 7.4         |
| Hispanic                              | 88   | 4.0         | 119                              | 4.1         |
| Other, Non-Hispanic                   | 129  | 5.9         | 158                              | 5.4         |
| Unknown Non-Hispanic <sup>3</sup>     | 275  | -           | 420                              | -           |
| <b>Prenatal Care</b>                  |  |             |                                  |             |
| Yes                                   | 2,457                                      | 99.5        | 3,179                            | 95.9        |
| No                                    | 12   | 0.5         | 135                              | 4.1         |
| <b>Maternal Education<sup>4</sup></b> |  |             |                                  |             |
| 12th Grade or Less                    | 616  | 25.1        | 811                              | 24.5        |
| High School Graduate or GED           | 267  | 10.9        | 482                              | 14.6        |
| Some College, No Degree               | 470  | 19.1        | 642                              | 19.4        |
| Associate Degree                      | 214  | 8.7         | 273                              | 8.3         |
| Bachelor Degree or More               | 891  | 36.3        | 1,103                            | 33.3        |
| <b>Trimester<sup>5</sup></b>          |  |             |                                  |             |
| None                                  | 12   | 0.5         | 135                              | 4.1         |
| 1                                     | 1,181                                      | 48.5        | 1,590                            | 48.8        |
| 2                                     | 995  | 40.9        | 1,224                            | 37.6        |
| 3                                     | 245  | 10.1        | 306                              | 9.4         |
| <b>Maternal Age</b>                   |  |             |                                  |             |
| < 20                                  | 21   | 0.9         | 58                               | 1.7         |
| 20 ≤ x < 25                           | 354  | 14.3        | 519                              | 15.6        |
| 25 ≤ x < 30                           | 820  | 33.2        | 1,083                            | 32.5        |
| 30 ≤ x < 35                           | 793  | 32.1        | 1,043                            | 31.3        |
| ≥ 35                                  | 481  | 19.5        | 630                              | 18.9        |

\* Data obtained from Michigan Birth Defects Registry records and from Michigan Newborn Screening Program records

<sup>1</sup> Frequency Missing: Midwife Attended = 54, All Births = 73

<sup>2</sup> Frequency Missing: Midwife Attended = 186, All Births = 242

<sup>3</sup> No marked race, but marked non-Hispanic

<sup>4</sup> Frequency Missing: Midwife Attended = 11, All Births = 22

<sup>5</sup> Frequency Missing: Midwife Attended = 36, All Births = 78

Table 2: Final Hearing Screen Results for Out-of-Hospital Births in Michigan from 2014-2016\*

| Results of Final Screen     | Attended by Midwives |             | All Births    |             |
|-----------------------------|----------------------|-------------|---------------|-------------|
|                             | Frequency (N)        | Percent (%) | Frequency (N) | Percent (%) |
| Pass                        | 1,111                | 45.0        | 1,734         | 52.0        |
| Fail                        | 24                   | 1.0         | 35            | 1.1         |
| Not Screened - Refused      | 1,055                | 42.7        | 1,179         | 35.4        |
| Not Screened - Other Reason | 15                   | 0.6         | 27            | 0.8         |
| No NBS Records, Only MBDR   | 264                  | 10.7        | 358           | 10.7        |

\*Data obtained from Michigan Newborn Screening Records

Table 3: Hearing Loss Diagnoses for Out-of-Hospital Births in Michigan from 2014-2016\*

| Diagnosis         | Attended by Midwives <sup>1</sup> |             | All Births <sup>2</sup> |             |
|-------------------|-----------------------------------|-------------|-------------------------|-------------|
|                   | Frequency (N)                     | Percent (%) | Frequency (N)           | Percent (%) |
| Both MBDR and NBS | 4                                 | 50          | 5                       | 31.3        |
| Only NBS          | 2                                 | 25          | 5                       | 31.3        |
| Only MBDR         | 2                                 | 25          | 6                       | 37.5        |

\* Data obtained from Michigan Birth Defects Registry records and from Michigan Newborn Screening Records

<sup>1</sup> 4 Failed final screen, 1 Not screened, 3 Passed final screen

<sup>2</sup> 8 Failed final screen, 3 Not Screened, 5 Passed final screen

Table 4: Population of Midwives who Attended Five or More Births Stratified by Percentage of Births with Blood Spot Screens and Newborn Screening Records Submitted in Michigan from 2014-2016\*

| Percent of Total Screens with Blood Spot Reported | Number of Midwives (N) | Percent (%) |
|---|------------------------|-------------|
| 0%  | 1                      | 1.4         |
| ≤50%  | 8                      | 11.6        |
| >50%, ≤75%  | 4                      | 5.8         |
| >75%  | 57                     | 82.6        |
| 100% Reported                                     | 22                     | 31.9        |

\*Data obtained from Michigan Newborn Screening records

Table 5: Population of Midwives who Attended Five or More Births Stratified by Percentage of Births with Hearing Screen Results Submitted in Michigan from 2014-2016\*

| Percent of Total Screens with Hearing Screen Results Reported | Number of Midwives (N) | Percent (%) |
|---|------------------------|-------------|
| 0% Reported   | 8                      | 11.6        |
| ≤25%  | 22                     | 31.9        |
| >25%, ≤50%  | 10                     | 14.5        |
| >50%, ≤75%  | 11                     | 15.9        |
| >75%  | 26                     | 37.7        |
| 100% Reported   | 3                      | 4.3         |

\*Data obtained from Michigan Newborn Screening records



## References

<sup>1</sup> Korzeniewski SJ, Grigorescu, V, Copeland G, Gu G, Thoburn KK, Rogers JD, & Young WI (2009). Methodological Innovations in Data Gathering: Newborn Screening Linkage with Live Births Records, Michigan, 1/2007–3/2008. *Maternal and Child Health Journal*. 2010;14(3): 360-364. <https://link.springer.com/article/10.1007%2Fs10995-009-0464-3>.

<sup>2</sup>The data analysis for this paper was generated using SAS software, Version 9.4 of the SAS System for Windows. Copyright © 2002-2012 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.