

Positive Predictive Value of Georgia's Part C Database to Identify and Connect Children Diagnosed with Hearing Loss to Early Intervention Services

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Background

- Children diagnosed with hearing loss (HL) that are reported to Georgia's (GA's) Early Hearing Detection and Intervention (EHDI) program are referred to GA's Part C program, Babies Can't Wait (BCW), for early intervention (EI). The EHDI and BCW programs maintain separate databases that are not linked, resulting in loss of HL diagnoses between both and missed opportunities for EI.
- The State Electronic Notifiable Disease Surveillance System (SendSS) is GA's reporting system for all notifiable diseases, including permanent HL under age 5 reported.
- This study aimed to evaluate the concordance of HL diagnoses, laterality, and type in the Part C database, Babies Information and Billing System (BIBS), compared to SendSS, the gold standard.

Methods

- BIBS was queried for records of children born from 2019–2022 with an ICD-10-CM diagnosis code for HL: F80.4 (Speech and language development delay due to HL), H90 (Conductive and sensorineural HL), H91 (Other and unspecified HL), and Q16–Q17 (Congenital malformations of the ear). If a child's record has more than one HL diagnosis code, the last listed or most recent HL diagnosis code was used.
- Each child's record was linked to SendSS to determine if a HL diagnosis (*yes, no*), laterality (*unilateral, bilateral*), and type (*conductive, sensorineural, mixed, auditory neuropathy spectrum disorder [ANSD], other/unspecified*) were documented.
- Positive predictive value (PPV) was calculated to determine the proportion of children with a HL diagnosis, laterality, or type in agreement in both BIBS and SendSS. Records in agreement in both BIBS and SendSS were defined as true positives (TP), and records not in agreement as false positives (FP). PPV was calculated as $TP / (TP + FP) \times 100$.
- SQL, Excel, and SAS were used for data analysis.

Results

PPV of Hearing Loss Diagnoses by Year of Birth

A total of 608 deduplicated records of children born from 2019–2022 were analyzed. PPV of HL diagnoses in BIBS compared to SendSS by year of birth ranged from 72.0% in 2020 to 88.7% in 2022 (Table 1).

Table 1. PPV of Hearing Loss Diagnoses in BIBS Compared to SendSS by Year of Birth, Georgia, 2019–2022

Measure	2019	2020	2021	2022	Total
True Positives (TP)	132	108	145	102	487
False Positives (FP)	38	42	28	13	121
TP + FP	170	150	173	115	608
PPV	77.7%	72.0%	83.8%	88.7%	80.1%

PPV of Hearing Loss Diagnoses, Laterality, and Type by ICD-10-CM Diagnosis Code

PPV of HL diagnoses in BIBS compared to SendSS by ICD-10-CM diagnosis code ranged from 6.6% for F80.4 to 97.7% for H90.42.

PPV of HL laterality ranged from 0.0% for F80.4, H91.90, and Q17.2 to 92.6% for H90.6. PPV of HL type ranged from 0.0% for F80.4 and H91.93 to 86.1% for H90.42 (Table 2). Only codes of $n \geq 10$ are shown.

Table 2. PPV of Hearing Loss Diagnoses, Laterality, and Type by ICD-10-CM Code in BIBS (N = 608) Compared to SendSS, Georgia, 2019–2022

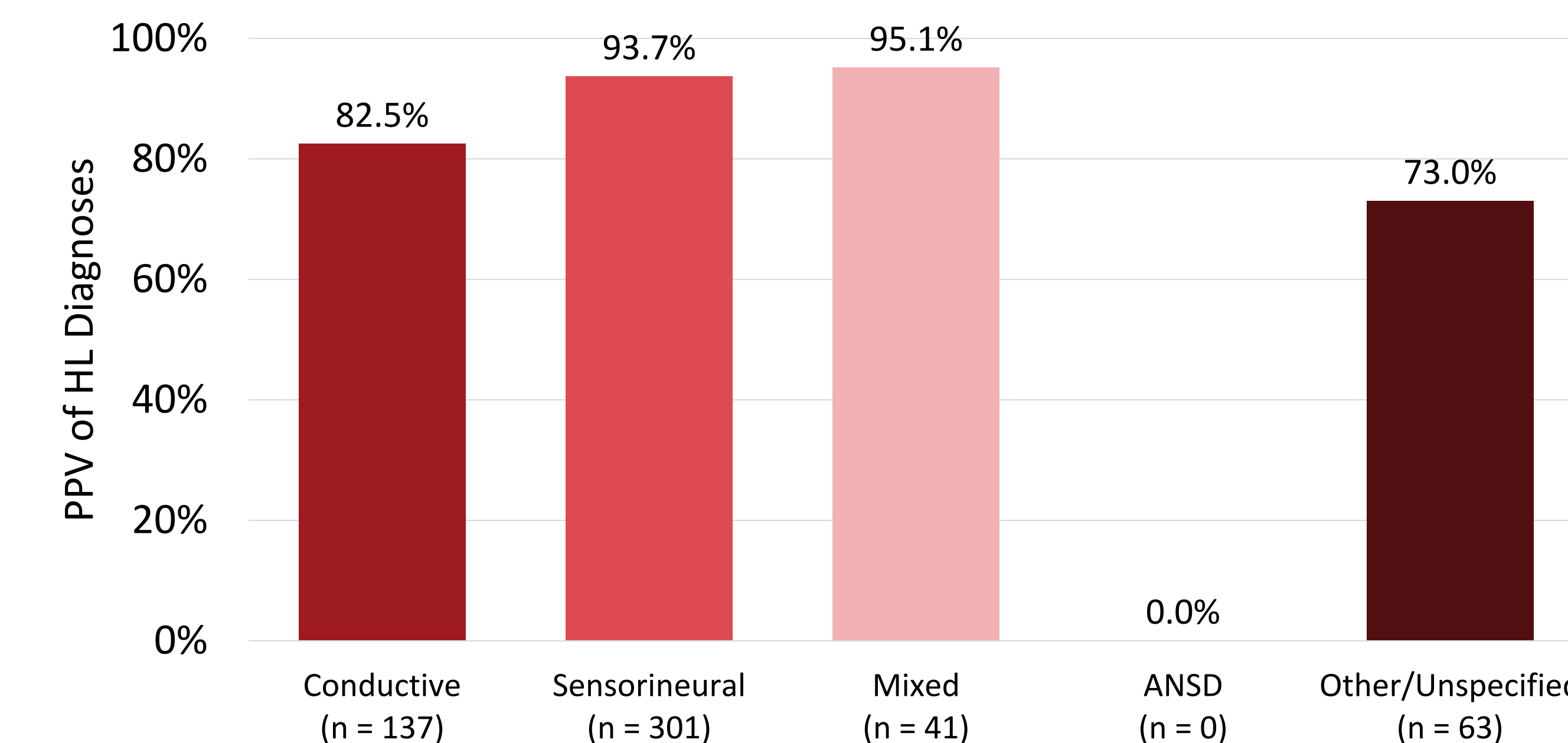
ICD-10-CM Diagnosis Code	n	PPV of HL Diagnosis	PPV of HL Laterality	PPV of HL Type
F80.4 Speech and language development delay due to HL	61	6.6%	0.0%	0.0%
H90.0 Conductive hearing loss, bilateral	73	76.7%	69.9%	37.0%
H90.11 Conductive hearing loss, unilateral, right ear	20	90.0%	85.0%	65.0%
H90.12 Conductive hearing loss, unilateral, left ear	18	88.9%	72.2%	83.3%
H90.3 Sensorineural hearing loss, bilateral	219	93.2%	91.8%	85.8%
H90.41 Sensorineural hearing loss, unilateral, right ear	33	93.9%	81.8%	81.8%
H90.42 Sensorineural hearing loss, unilateral, left ear	43	97.7%	83.7%	86.1%
H90.6 Mixed conductive and sensorineural hearing loss, bilateral	27	96.3%	92.6%	81.5%
H91.90 Unspecified hearing loss, unspecified ear	11	63.6%	0.0%	36.4%
H91.93 Unspecified hearing loss, bilateral	20	70.0%	65.0%	0.0%
Q17.2 Microtia*	13	76.9%	0.0%	69.2%
All other codes of $n < 10$	70	84.3%	37.1%	55.7%
Total	608	80.1%	67.3%	62.7%

*Conductive HL can be inferred from a diagnosis of microtia or atresia.

PPV of Hearing Loss Diagnoses and Laterality by Type

PPV of HL diagnoses in BIBS compared to SendSS by HL type ranged from 73.0% for other/unspecified to 95.1% for mixed (Figure 1). No HL diagnoses were coded as ANSD in BIBS.

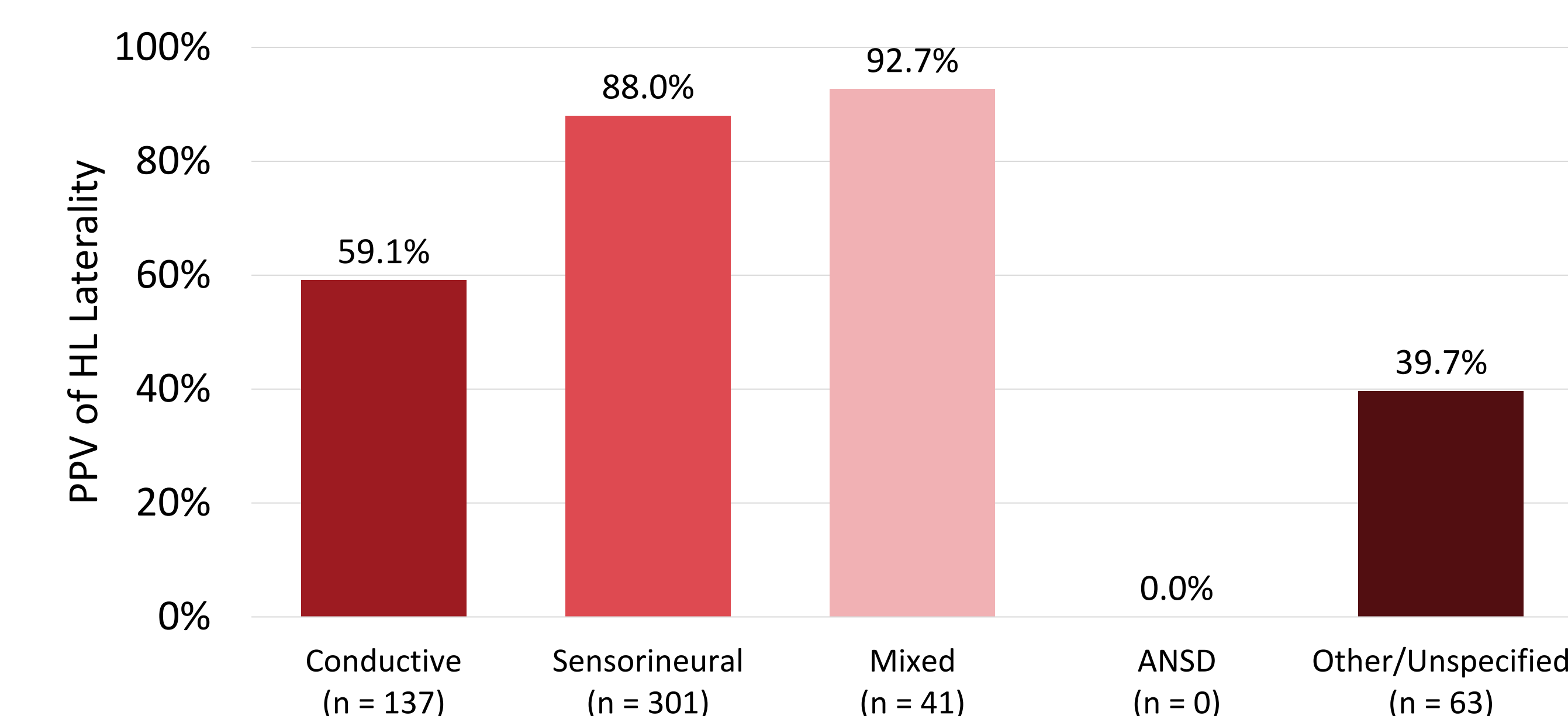
Figure 1. PPV of Hearing Loss Diagnoses in BIBS Compared to SendSS by Hearing Loss Type† (N = 542), Georgia, 2019–2022



†Excludes the following diagnosis codes due to lack of HL type specified: F80.4 (Speech and language development delay due to HL) and H90 (Conductive and sensorineural HL), which is nonspecific.

PPV of HL laterality in BIBS compared to SendSS by HL type ranged from 39.7% for other/unspecified to 92.7% for mixed (Figure 2). No HL diagnoses were coded as ANSD in BIBS.

Figure 2. PPV of Hearing Loss Laterality in BIBS Compared to SendSS by Hearing Loss Type† (N = 542), Georgia, 2019–2022



†Excludes the following diagnosis codes due to lack of HL type specified: F80.4 (Speech and language development delay due to HL) and H90 (Conductive and sensorineural HL), which is nonspecific.

Discussion

- F80.4 had the lowest PPV possibly because this diagnosis code was entered in BIBS before an audiological diagnostic evaluation was made. In this study, only three of the 61 children with this diagnosis code in BIBS were evaluated for speech delay according to SendSS.
- Although H90.0–2 do not distinguish between permanent and transient conductive HL, this distinction is made in audiological practice for the purposes of treatment, amplification, and EI.
- ICD-10-CM HL diagnosis codes do not capture degree of HL, which is a limitation of the ICD-10-CM.
- Bilateral HL of different types should be coded using two ICD-10-CM diagnosis codes. This was properly done in only two of the 28 BIBS records reviewed where bilateral HL of different types was documented in SendSS.
- ANSD should be coded as H93.3X_ (Disorders of acoustic nerve), but was instead improperly coded as conductive, sensorineural, or other/unspecified HL in the 24 BIBS records reviewed where ANSD was documented as the HL type in SendSS.
- Of the 608 total BIBS records reviewed with an ICD-10-CM HL diagnosis code, 120 (19.7%) did not have an audiological diagnostic evaluation documented in SendSS.

Conclusion

When compared to SendSS, the gold standard, BIBS has a high PPV of HL diagnoses overall, but this varies widely by individual ICD-10-CM HL diagnosis codes, laterality, and type.

Public Health Implications

- Establish a feedback loop between BCW and EHDI to follow up on children referred to BCW with a HL diagnosis, but not to EHDI.
- Analyze racial/ethnic/geographic/health disparities in referrals and PPV.
- Conduct sensitivity analysis of ICD-10-CM diagnosis code F80.4.
- Provide training to BCW intake and service coordinators to improve the quality of ICD-10-CM diagnosis codes entered in BIBS.