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Does an Otolaryngology-Specific Database Have Added Value? A Comparative Feasibility Analysis

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Author Contributions

Angela M. Bellmunt, analysis and variable assignment, drafted a portion of the initial manuscript, acquired data, and approved the final manuscript as submitted; **Rhonda Roberts**, analysis and variable assignment, drafted a portion of the initial manuscript, acquired data, and approved the final manuscript as submitted; **Walter T. Lee**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **Kristine Schulz**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **Melissa A. Pynnonen**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **Matthew G. Crowson**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **David Witsell**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **Kourosh Parham**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **Alan Langman**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **Andrea Vambutas**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **Sheila E. Ryan**, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted; **Jennifer J. Shin**, drafted a portion of the initial manuscript, reviewed and revised the manuscript, contributed to the project design, presentation and interpretation of the data, and approved the final manuscript as submitted.

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Supplemental Material

Additional supporting information may be found at <http://otojour-nal.org/supplemental>.

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Abstract

Objectives—There are multiple nationally representative databases that support epidemiologic and outcomes research, and it is unknown whether an otolaryngology-specific resource would prove indispensable or superfluous. Therefore, our objective was to determine the feasibility of analyses in the National Ambulatory Medical Care Survey (NAMCS) and National Hospital Ambulatory Medical Care Survey (NHAMCS) databases as compared with the otolaryngology-specific Creating Healthcare Excellence through Education and Research (CHEER) database.

Study Design—Parallel analyses in 2 data sets.

Setting—Ambulatory visits in the United States.

Subjects and Methods—To test a fixed hypothesis that could be directly compared between data sets, we focused on a condition with expected prevalence high enough to substantiate availability in both. This query also encompassed a broad span of diagnoses to sample the breadth of available information. Specifically, we compared an assessment of suspected risk factors for sensorineural hearing loss in subjects 0 to 21 years of age, according to a predetermined protocol. We also assessed the feasibility of 6 additional diagnostic queries among all age groups.

Results—In the NAMCS/NHAMCS data set, the number of measured observations was not sufficient to support reliable numeric conclusions (percentage standard error among risk factors: 38.6–92.1). Analysis of the CHEER database demonstrated that age, sex, meningitis, and cytomegalovirus were statistically significant factors associated with pediatric sensorineural hearing loss ($P < .01$). Among the 6 additional diagnostic queries assessed, NAMCS/NHAMCS usage was also infeasible; the CHEER database contained 1585 to 212,521 more observations per annum.

Conclusion—An otolaryngology-specific database has added utility when compared with already available national ambulatory databases.

Keywords

practice-based network; otolaryngology; database; methodology; hearing loss; pediatric; sudden hearing loss; chronic otitis media; cholesteatoma; Ménière's disease; inferior turbinate hypertrophy; adenoid hypertrophy; registry

Practice-based networks are composed of clinicians working together to answer key health care questions and translate research results into practice.^{1–3} Such networks have been successfully implemented in multiple fields, including internal medicine, family practice, nursing, and dentistry.⁴ Recent advances have allowed for the establishment of a national practice-based network in otolaryngology–head and neck surgery,³ which has the notable advantage of representing the full spectrum of otolaryngology practitioners. It encompasses clinicians from not only academic sites but community practices as well. In addition, the network has a proven capacity to complete prospective studies across multiple sites. Accordingly, a dedicated practice-based network has the key benefit of supporting

standardized data collection. These common data may then be combined to form a nationally representative database with the capacity for ongoing analysis.

There are, however, additional national data sets that are already available for study. Among the best-known and most widely utilized data sets are those overseen by the National Center for Health Statistics, such as the National Health and Nutrition Examination Survey, the National Ambulatory Medical Care Survey (NAMCS), and the National Hospital Ambulatory Medical Care Survey (NHAMCS). These databases are frequently leveraged for study, as they afford readily available insight into many common symptoms and diagnoses. These databases, however, are not focused on otolaryngology complaints; in fact, among NAMCS/NHAMCS visits in 2005 to 2010, only 1.7% of visits were to otolaryngologists. Nonetheless, these data sets are large, and 1.7% translates into nearly 10,000 observed visits in that time frame, which could already prove adequate for many inquiries.

Since a great deal of time, effort, and expense are required for the creation and maintenance of a large database, the question then arises whether an otolaryngology-specific database has added utility over already available national data sets. Because the answer to this question has immediate, actionable implications related to epidemiologic and outcomes research, we sought to determine whether a current, high-impact public health inquiry could be similarly addressed using data from the National Center for Health Statistics and that from an otolaryngology-specific database. The latter has been compiled by the otolaryngology practice-based network Creating Healthcare Excellence through Education and Research (CHEER). Specifically, our objective was to determine the comparative feasibility of the same analysis in the NAMCS/NHAMCS and CHEER databases, focusing on the association between suspected risk factors for the increasingly prevalent diagnosis of pediatric sensorineural hearing loss (SNHL). We also assessed the comparative feasibility of 6 additional diagnostic inquiries among all age groups:

Objective 1: To evaluate which risk factors are associated with pediatric SNHL, comparing the CHEER and NAMCS/NHAMCS databases.

Objective 2: To determine whether 6 additional diagnoses—chronic otitis media, cholesteatoma, sudden hearing loss, Ménière's disease, adenoid hypertrophy, turbinate hypertrophy—had sufficient observations for analysis within each database, also comparing CHEER and NAMCS/NHAMCS.

Methods

Planned protocols were reviewed by the Partners Institutional Review Board and the Duke University School of Medicine Institutional Review Boards, which both determined that the de-identified data analysis was exempt from oversight.

Databases

Two nationally representative databases were evaluated. First, we assessed the combined NAMCS and NHAMCS data from 2010, the most recent year available at the time that the protocol was finalized (2011 data became available on December 16, 2015). These surveys encompass a broad sampling of out-patient visits to office-based physicians and hospitals

and are appended through previously described techniques.^{5,6} The National Center for Health Statistics oversees the databases, and full descriptions are available online.^{7,8} The center recommends that estimates be based on >30 affected observations with a standard error <30% of the point estimate to support numeric reliability. If these standards are met, then application of visit weights generates estimates representative of all ambulatory care visits in the United States; each visit has an assigned individual weight, facilitating weighted analysis across ambulatory settings.⁹ If these standards are not met, then the associated data are not considered reliable. Stated in more basic lay terms, if there are 29 observations with a diagnosis of interest, then the data are too sparse to be trusted (consider a similar concept: if one flipped a coin twice and got heads both times, one could not then conclude with confidence that there were heads on both sides of the coin). Similarly, if the standard error is more than the number obtained by multiplying 0.30 and the calculated estimate, then the data are not precise enough to be considered reliable for use (consider a similar concept: if a 95% confidence interval spans 0 to 10,000,000, then one cannot feel confident about what the true measurement really is). As for weights, since it is somewhat prohibitive to measure the multiple millions of people in the US population, NAMCS/NHAMCS instead samples a representative selection. That representative sample, however, needs to be chosen carefully (not just at random). Based on this preestablished, careful selection process, those overseeing the data collection may then provide weights that mathematically describe their sampling process. It is, however, only valid to apply those weights in situations where the 2 conditions described above are met (ie, the phrasing immediately following “Stated in more basic lay terms”).

Second, we evaluated data from the CHEER Retrospective Data Collection (RDC) database, which arises from the otolaryngology practice-based network. This database was developed to provide potential investigators with measured estimates of site-specific data for patients seen in the network. The CHEER network comprises 29 provider sites in 19 states totaling more than 200 otolaryngologists, 100 audiologists, and 50 speech language pathologists. The database captures >650,000 unique encounters from >260,000 unique patients from 22 sites; participating sites have contributed all recorded diagnoses for a full year of patient visits from either 2011–2012 or 2012–2013. Data are available at both the visit level and the patient level so that patients can be followed longitudinally within that year as well. Data can be analyzed directly, and no weighting process is necessary.

Delineation of Focused Inquiry

Since our objective was to compare the feasibility of the same inquiry in 2 distinct databases, we sought first to delineate a focused query that could be reliably duplicated in both NAMCS/NHAMCS and CHEER RDC. In addition, the ideal inquiry would center on a condition with a prevalence high enough to substantiate an expected availability in both data sets; it would also involve numerous diagnoses to span the breadth of the database. Furthermore, since the goal was to determine the comparative database utility, rather than uncover new clinical information, it was considered beneficial to choose a topic that had previously been studied so that results from both data sets could be viewed in the context of what is already known. Finally, an ideal inquiry would focus on a topic of ongoing, broad-based interest among clinicians.

Pediatric hearing loss is an increasingly prevalent condition with numerous associated risk factors, both established and arguable.^{10–15} SNHL in children has been linked with not only immediate problems, such as compromised quality of life and academic performance, but also long-term consequences, including lower graduation rates and an increased risk of unemployment.^{16–20} As concerns have been raised that the condition is becoming disturbingly widespread (19.5% of adolescents in recent reports),²¹ understanding potential causes continues to pique the interest of physicians, audiologists, educators, and the lay populace at large.^{22–24} The prevalence is high enough that the condition would be expected to be present in sufficient numbers to support a database study. In addition, multiple risk factors for pediatric SNHL have been studied^{25–31} such that a related inquiry would be expected to have reliable, anticipatable outcomes spanning a broad spectrum of variables. We therefore focused our comparative inquiry on risk factors associated with pediatric SNHL, as these collective features made this assessment an attractive choice for a comparison between databases.

The study population included patients 0 to 21 years old who had ambulatory visits during the most recently available 1-year interval in each data set. All provider types were included. The outcome and predictor variables were defined according to all available *International Classification of Diseases, Ninth Revision (ICD-9)* codes in both databases (see Appendix 1 at www.otojournal.org/supplemental). The primary outcome of interest was SNHL, which was defined by *ICD-9* codes that clearly delineated SNHL or mixed hearing loss. Subjects who had any of the listed *ICD-9* codes corresponding to SNHL in any diagnostic field were considered positive. Since there is not a diagnostic code that defines the absence of SNHL, subjects were considered to be without SNHL if they were without all of the following: SNHL, unspecified hearing loss, or “other specified” hearing loss. The latter 2 diagnoses were excluded because they could have a sensorineural, conductive, or mixed component. The primary predictor variables of interest were as follows: age, sex, family history, meningitis, cytomegalovirus, noise exposure, premature/low birth weight, nutrition deficiencies, hypoxemia, head trauma, and tobacco exposure. Independent risk factors were defined by the presence or absence of related *ICD-9* codes. In the CHEER RDC data set, risk factors were assigned to each patient in the following way: If a proposed risk factor’s *ICD-9* code was entered at any visit during the year preceding a SNHL diagnosis, then that patient was considered positive for that risk factor. Those who did not have that *ICD-9* code at any point during that observed year were considered negative. Among patients who did not have SNHL, the presence or absence of that risk factor was assigned on the basis of their visits throughout the same observed year.

Analyses were planned a priori to be certain that they could be performed in parallel between the 2 databases. The protocol was established to assess the presence or absence of SNHL and each risk factor and to evaluate for associations in univariate analyses of dichotomous variables. Given that the number of instances of each condition might vary among sites, Fisher’s exact test was utilized to assess all associations aside from age so that small numbers of affected patients would not vary the statistical analyses between the databases. Age was considered in ordinal categories; the associated odds ratio was calculated via standard logistic regression techniques.³² We followed standard protocols for NAMCS/NHAMCS related to assessing the number of observed visits and the percentage

standard error (as described under the Databases heading), prior to performing any weighted analysis.

Additional Diagnostic Queries

In a more generalized analysis, we also assessed the sample sizes available among a series of additional otolaryngology diagnoses: chronic otitis media, sudden hearing loss, Ménière's disease, cholesteatoma, inferior turbinate hypertrophy, and adenoid hypertrophy. These diagnoses were selected for focus, as they are frequently seen among otolaryngologists; in addition, they are topics that would likely engender future clinical research. Diagnoses were defined by *ICD-9* codes in both the NAMCS/NHAMCS and the CHEER RDC (Appendix 1, available online). In this analysis, all age groups were included. This additional inquiry into the observed number of visits was performed to determine if similar limitations and capabilities were present beyond the topic of focused inquiry, particularly when all age groups were included. All analyses were performed in Stata 13.0 (Stata Corp, College Station, Texas) and SAS 9.4 (SAS Institute, Cary, North Carolina).

Results

Focused Inquiry: Risk Factors for Pediatric SNHL

The NAMCS/NHAMCS data set was first assessed to determine if there was an adequate number of observations to support a weighted analysis—that is, if there were at least 30 affected unweighted observations with a standard error <30% of the point estimate. Within the year of data, these criteria were not met (Table 1). This database included 14 unweighted observations of pediatric SNHL. In addition, the number of pediatric observations who had risk factors of common interest was limited, with 21 unweighted observations having a designated family history of hearing loss and even fewer instances among other diagnoses (Table 1). In addition, most standard errors were >30% of the point estimate, also precluding a reliable data analysis. Thus, the data screen showed that the observed numbers did not meet the National Center for Health Statistics' criteria that would permit reliable application of visit weights to calculate nationally representative visit data.

The CHEER RDC database was then queried to determine its feasibility for the same inquiry. Among 82,258 pediatric patients, 4623 (5.6%) had SNHL. Among the risk factors assessed, there were sufficient numbers to perform numeric hypothesis testing for potential associations (Table 2). Age, sex, meningitis, family history of hearing loss, and cytomegalovirus all demonstrated a statistically significant association with SNHL ($P < .005$). Head trauma and tobacco exposure had odds ratios suggestive of an association, but neither achieved statistical significance; the preceding statement does not include or imply any comment about trend but rather describes the lack of statistical significance. The determination of a directly calculated odds ratio was limited in the case of noise exposure, because it was perfectly predictive of SNHL; this collinear relationship prevented the direct calculation of a point estimate and variance, as the associated odds ratio would thus have approached infinity. As similarly noted in the note to Table 2, for premature birth/low birth weight and vitamin/nutrition deficiencies, direct calculation of the odds ratio according to

the standard means is hindered by the zero cell value; as an inherent mathematical property, division by 0 is not permitted.

Additional Diagnostic Queries

We subsequently evaluated the number of visits associated with a diagnosis of chronic otitis media, sudden hearing loss, Ménière's disease, cholesteatoma, inferior turbinate hypertrophy, and adenoid hypertrophy in all age groups. This assessment also showed that observations were limited in NAMCS/NHAMCS as compared with the CHEER RDC data set (Table 3). While there were <30 visits for each of these diagnoses in the NAMCS/NHAMCS data set such that criteria for reliability were again not satisfied, the CHEER RDC encompassed 1589 to 212,521 related visits in the collected year's data.

Discussion

These data demonstrate that when the same focused inquiry was made to determine the significance of risk factors associated with pediatric SNHL, the study could be completed in the CHEER RDC data set but not the NAMCS/NHAMCS data set. Given that this is not a particularly unusual topic of inquiry, this finding suggests that an otolaryngology-specific database would have important, concrete applications that extend beyond that of the already available national databases. In addition, further inquiry into 6 additional diagnoses revealed that these too would be feasible only in the otolaryngology-specific database.

The NAMCS/NHAMCS data set is a rich resource that has supported many scientific inquiries, including those focused on otolaryngologic topics such as otitis media, rhinitis, and obstructive sleep apnea.^{33–36} It has also provided data for pediatric-specific inquiries on a broader scale.^{37,38} Nonetheless, for the basic inquiry into the risk factors for pediatric SNHL over a 1-year time frame, the database did not house adequate observations for a complete analysis. This effect was compounded as NAMCS/NHAMCS uses a weighted system to develop nationally representative samples. In other circumstances, a small number of observations might still be numerically assessed via appropriate statistical techniques, but here, if minimum threshold criteria are not met, then no reliable conclusions can be drawn. Whereas this feature proved a disadvantage in this case, it is one that can be advantageous when those minimum threshold criteria are met, as small numbers of unweighted observations will translate into a notably larger number of visits when appropriate weights are applied.

The CHEER RDC database encompassed 4623 pediatric patients with SNHL within a 1-year time span, which formed a sufficient number to form the basis of a focused inquiry. The data confirmed that age, sex, meningitis, cytomegalovirus, and family history of hearing loss, were all predictors of SNHL, as has been demonstrated in previous studies,^{31,39,40} supporting the validity of the underlying data collection. We also assessed purported risk factors that have had a controversial association with SNHL, such as tobacco exposure and head trauma, and these results also remain aligned with the prior body of literature (Appendix 2, available online). CHEER's otolaryngology-specific database supported the proposed assessment. In addition, the American Academy of Otolaryngology—Head and Neck Surgery Foundation has laid the groundwork for Regent, a specialty-wide registry.

Regent derives data from electronic health records to document the value of care provided by members and to track the quality of care and outcomes. It entered the scheduled pilot phase in the spring of 2016 (www.entnet.org/regent). Three members of the CHEER team have also been participating in this process, through the Registry Task Force (D.W., J.J.S.) and Registry Executive Committee (M.A.P., J.J.S.).

As planned a priori, the NAMCS/NHAMCS and CHEER analyses focused on the most recently available year for analysis at the time that this protocol was planned. While studies often focus on a 1-year time frame, expanding to include multiple years is a strategy that can be utilized to increase sample size and power. It is possible that combining multiple years of NAMCS/ NHAMCS surveys would provide adequate data for a reliable numeric analysis for the present focused query. A post hoc data extraction from the combined 2007–2010 databases suggested that 4 years of data would be needed to obtain reliable numbers for the epidemiology of pediatric SNHL visits, with more years needed to reliably assess for an association with purported risk factors. Increasing the CHEER database beyond a 1-year set would also increase the potential sample size for future relevant studies. Multiple years of the NAMCS/NHAMCS databases are available through the National Center for Health Statistics (http://www.cdc.gov/nchs/ahcd/about_ahcd.htm). The CHEER database is available through this consortium (<http://www.cheerresearch.org/>).

There are limitations to both the CHEER RDC data set and this study. First, the CHEER database currently encompasses 1 year, which may have limited the ability to detect statistical significance in the tobacco and head trauma analysis. It remains possible that risk factors were present and coded in prior years that were not captured in either database. As this was the initial site collection for the database project, modest goals were set. It is anticipated, however, that over time additional years will be included, allowing for more longitudinal analyses. Second, the CHEER RDC data set is currently limited to demographics, diagnoses, and procedures. NAMCS/NHAMCS, in contrast, includes information regarding medication and race/ethnicity—both of which are limited in the current CHEER RDC database. Third, while the CHEER RDC database has the advantage of focusing on conditions that present frequently in daily otolaryngology practice, it also has the inherently associated potential for referral bias. Referral bias may occur when those in a study are distinct from the affected population at large.^{41,42} For example, patients referred to specialty practices may have a higher prevalence or severity of disease. At least in the present study, this did not prove to be the case. While recent reports have raised concern that hearing loss is present in approximately 20% of adolescents, our current data suggest a more limited prevalence of 5.9% to 8.3% among visits in that age group. This lower prevalence may be attributable to differences in study design. The prior study utilized only air conduction audiometry to define hearing loss (ie, cases may have been conductive as well as sensorineural). Differences may also be due to limitations in the CHEER database, as diagnostic coding may prove less sensitive than specific.⁴³

Additional limitations pertain to how the data are collected and the retrospective nature of their evaluation. Fourth, the *ICD-9* coding done during the office visits that form the basis for both databases may not completely or accurately reflect the true disease state. In addition, it is unknown whether these diagnoses were supported by the ideal means of

hearing evaluation (ie, formal audiometry). *ICD-9* coding may also lack nuance. For example, an *ICD-9* code reflects a family history of hearing loss, but genetic associations with hearing loss encompass a broad and heterogeneous compilation of sporadic instances, inheritance patterns, genes, and syndromic links.⁴⁴ To classify all genetic hearing loss under one variable ignores the complexity of the potential genetic relationships. Finally, although the CHEER database encompasses a large variety of academic and community practices, it remains a convenience sample. NAMCS/NHAMCS, in contrast, uses a population-based survey design that allows for more accurate extrapolation to the US population when the number of sampled observations permits.

Conclusions

When the same focused inquiry was made to determine the significance of risk factors associated with pediatric SNHL, the study could be completed in the CHEER database but not the NAMCS/NHAMCS database. In addition, the visit frequency of 6 key otolaryngology diagnoses suggests feasibility in the CHEER database but not NAMCS/NHAMCS. These findings suggest that an otolaryngology-specific database would have concrete applications that extend beyond that of the already available national ambulatory databases.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Risk Factors for Pediatric Hearing Loss: National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey (Single-Year Data, Unweighted Observations).

	Patients, n (%)		Total, n	Percentage SE
	No SNHL	SNHL ^a		
All	25,882 (99.95)	14 (0.05)	25,896	44.1
Age				
0–12 mo	3037 (100.00)	0 (0.00)	3037	4.2
>1–2 y	2158 (99.95)	1 (0.05)	2159	4.8
>2–4 y	2811 (99.96)	1 (0.04)	2812	4.4
>4–7 y	3006 (99.90)	3 (0.10)	3009	4.3
>7–10 y	2525 (99.76)	6 (0.24)	2531	4.1
>10–13 y	2524 (99.96)	1 (0.04)	2525	5.1
>13–16 y	2707 (99.96)	1 (0.04)	2708	4.2
>16–19 y	3349 (99.97)	1 (0.03)	3350	4.7
>19–21 y	3765 (100.00)	0 (0.00)	3765	5.9
Sex				
Male	12,744 (99.96)	5 (0.04)	12,749	1.6
Female	13,138 (99.93)	9 (0.07)	13,147	1.6
Family history				
No	25,861 (99.95)	14 (0.05)	25,875	51.6
Yes	21 (100%)	0 (0.00)	21	
Meningitis				
No	25,878 (99.95)	14 (0.05)	25,892	62.1
Yes	4 (100.00)	0 (0.00)	4	
Cytomegalovirus				
No	25,882 (99.95)	14 (0.05)	25,896	— ^b
Yes	0 (0.00)	0 (0.00)	0	
Noise exposure				
No	25,882 (99.95)	14 (0.05)	25,896	— ^b
Yes	0 (0.00)	0 (0.00)	0	
Premature birth / low birth weight				
No	25,865 (99.95)	14 (0.05)	25,879	71.6
Yes	17 (100.00)	0 (0.00)	17	
Vitamin / nutrition deficiencies				
No	25,873 (99.95)	14 (0.05)	25,887	67.0
Yes	9 (100.00)	0 (0.00)	9	
Hypoxemia				
No	25,848 (99.95)	14 (0.05)	25,862	61.5
Yes	34 (100.00)	0 (0.00)	34	
Head trauma				
No	25,880 (99.95)	14 (0.05)	25,894	92.1

	Patients, n (%)		Total, n	Percentage SE
	No SNHL	SNHL ^a		
Yes	2 (100.00)	0 (0.00)	2	
Tobacco exposure ^a				
No	25,839 (99.95)	14 (0.05)	25,853	38.6
Yes	43 (100.00)	0 (0.00)	43	

Abbreviation: SNHL, sensorineural hearing loss. SE, standard error

^aThe weighted number of represented visits cannot be extrapolated, due to the limited numbers of affected observations.

^bThe percentage standard error could not be calculated, because there were no affected observations.

Table 2
Risk Factors for Pediatric Hearing Loss: Creating Healthcare Excellence through Education and Research Network (Single-Year Data).

	Patients, n (%)			Total, n	OR (95% CI)	P Value ^d
	No SNHL	SNHL				
All	77,635 (94.38)	4623 (5.62)		82,258	—	—
Age						
0–12 mo ^b	8973 (95.42)	431 (4.58)		9404	1.08 (1.07–1.20)	<.0001
>1–2 y	6367 (96.81)	210 (3.19)		6577		
>2–4 y	12,104 (96.38)	455 (3.62)		12,559		
>4–7 y	14,930 (94.73)	830 (5.27)		15,760		
>7–10 y	9059 (92.72)	711 (7.28)		9770		
>10–13 y	6245 (92.14)	533 (7.86)		6778		
>13–16 y	5468 (91.73)	493 (8.27)		5961		
>16–19 y	5429 (93.27)	392 (6.73)		5821		
>19–21 y	9060 (94.10)	568 (5.90)		9628		
Sex						
Male ^b	35,427 (94.15)	2201 (5.85)		37,628	0.92 (0.87–0.98)	.0090
Female	42,194 (94.57)	2421 (5.43)		44,615		
Family history						
No ^b	77,517 (94.44)	4560 (5.56)		82,077	9.08 (6.67–12.34)	<.0001
Yes	118 (65.19)	63 (34.81)		181		
Meningitis						
No ^b	77,626 (94.38)	4619 (5.62)		82,245	7.47 (2.30–24.30)	.0047
Yes	9 (69.23)	4 (30.77)		13		
Cytomegalovirus						
No ^b	77,630 (94.38)	4619 (5.62)		82,249	13.45 (3.61–50.09)	.0001
Yes	5 (55.56)	4 (44.44)		9		
Noise exposure						
No ^b	77,635 (94.41)	4596 (5.59)		82,231	— ^c	N/A
Yes	0 (0.00)	27 (100.00)		27		

	Patients, n (%)		Total n	OR (95% CI)	P Value ^d
	No SNHL	SNHL			
Premature birth / low birth weight					
No ^b	77,627 (94.38)	4623 (5.62)	82,250	— ^c	N/A
Yes	8 (100.00)	0 (0.00)	8		
Vitamin / nutrition deficiencies					
No ^b	77,631 (94.38)	4623 (5.62)	82,254	— ^c	N/A
Yes	4 (100.00)	0 (0.00)	4		
Hypoxemia					
No ^b	77,397 (94.38)	4613 (5.62)	82,010	0.71 (0.37–1.33)	.3336
Yes	238 (95.97)	10 (4.03)	248		
Head trauma					
No ^b	77,609 (94.38)	4619 (5.62)	82,228	2.58 (0.90–7.41)	.0854
Yes	26 (86.67)	4 (13.33)	30		
Tobacco exposure					
No ^b	77,578 (94.38)	4619 (5.62)	82,197	1.17 (0.43–3.25)	.7769
Yes	57 (93.44)	4 (6.56)	61		

Abbreviations: 95% CI, 95% confidence interval; N/A, not applicable; OR, odds ratio; SNHL, sensorineural hearing loss.

^aFisher's exact test.

^bReference category.

^cDirect calculation of the OR is hindered by the zero cell value (an inherent mathematical property). In the case of noise exposure, it predicted SNHL without fail. The *P* values cannot be calculated, due to the 0 values.

Table 3

Number of Observed Affected Visits by Otolaryngology Diagnosis: All Ages, 1 Year.

Diagnosis	NAMCS/NHAMCS	CHEER RDC
Chronic otitis media	8	6321
Sudden hearing loss	4	1589
Meniere disease	21	6669
Cholesteatoma	10	5170
Adenoid hypertrophy	13	8979
Turbinate hypertrophy	0	212,521

Abbreviations: CHEER RDC, Creating Healthcare Excellence through Education and Research Retrospective Data Collection; NAMCS, National Ambulatory Medical Care Survey; NHAMCS, National Hospital Ambulatory Medical Care Survey.