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Incidence of Sudden Sensorineural Hearing Loss

Thomas H. Alexander and Jeffrey P. Harris

Division of Otolaryngology–Head and Neck Surgery, University of California-San Diego; and VA Medical Center, San Diego, California, U.S.A.

Objective: Recent data regarding the incidence of sudden sensorineural hearing loss (SSNHL) in the United States is lacking. The objective of this study was to assess the current day incidence of SSNHL in the United States using data from a medical and pharmaceutical claims database containing information for more than 60 million unique patients.
Study Design: Population-based cross-sectional analysis.
Setting: Inpatient and outpatient.
Patients: Patients in the database are reported to be representative of the national, commercially insured population on a variety of demographic measures including age, sex, health plan type, and geographic location.
Results: During 2006 and 2007, the annual incidence of SSNHL was 27 per 100,000 in the United States. The incidence increased with increasing age, ranging from 11 per 100,000 for patients younger than 18 years to 77 per 100,000 for patients 65 years and older. There was an overall slight male preponderance with a male-to-female ratio of 1.07:1. This was more pronounced in patients 65 years and older, with a ratio of 1.30:1.
Conclusion: More than 66,000 new cases of SSNHL are seen annually in the United States. The disorder is more common in men and the elderly. **Key Words:** Epidemiology—Incidence—Sudden sensorineural hearing loss.
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Sudden sensorineural hearing loss (SSNHL) is often defined as a unilateral loss of hearing occurring over 24 to 72 hours with 30 dB or more loss in at least 3 contiguous frequencies on pure-tone audiogram. The majority of cases are idiopathic, with a specific cause identified in fewer than 30% of patients presenting with SSNHL (1).

Previous reports of the annual incidence of SSNHL have ranged from 4 to 160 per 100,000 (2–6). Many publications cite an annual incidence of SSNHL of 5 to 20 per 100,000 from a 1984 article by Byl (3). The numbers in Byl's article are found in a paragraph reviewing the epidemiology of SSNHL. Interestingly, he did not cite his own previous study from 1977 showing an incidence of 10.7 per 100,000 (2), although this fell within the range given. The 5 per 100,000 value is cited as being derived from an unpublished personal communication from Jaffe. The source of the 20 per 100,000 number is not referenced. An incidence of 10 per 100,000 from a French language article by van Caneghem is cited (7), but a closer evaluation of this article reveals that this number is probably not an annual incidence. The author described 64 cases of sudden hearing loss he encountered in the Province of West Flanders in Belgium but did not indicate the time interval during which they presented.

Most of the available studies that do calculate an annual incidence are retrospective reviews that identify the number of cases treated at a group of hospitals and clinics by analyzing medical records (2,4,5). The denominator for the incidence calculation is then derived from the population served by these hospitals and clinics. This methodology introduces sampling bias, as many patients in the population with the disease may not have been treated at the hospitals in the study for a variety of reasons.

Population-based cross-sectional studies are the most accurate method of determining epidemiologic characteristics of a disorder. They reduce sampling bias by surveying random samples of the general population. The incidence in the population can then be inferred from the exact value in the sample group. In relatively rare disorders such as SSNHL, very large sample sizes are needed to achieve accurate epidemiological estimates of the disease, making these studies prohibitively costly and time consuming.

More recently, health insurance claims databases have been used to gather population-based epidemiologic data for large cohorts. Using this methodology, Wu et al. (6) found an annual incidence of SSNHL in Taiwan of 10.21 per 100,000 in 2002. To further define the current incidence of SSNHL in the general population of the United States, we

Address correspondence and reprint requests to Thomas H. Alexander, MD, MHS, University of California, San Diego, Division of Otolaryngology–Head and Neck Surgery, 200 W. Arbor Drive, Mail Code 8895, San Diego, CA 92103; E-mail: thalexander@ucsd.edu

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analyzed data from a large health claims database containing information for more than 60 million patients.

METHODS

The IMS Lifelink Health Plan Claims Database (IMS Health, Danbury, CT) is composed of fully adjudicated medical and pharmaceutical claims for more than 60 million unique patients from 97 health plans across the United States. Patients in the database are reportedly representative of the national, commercially insured population on a variety of demographic measures including age, sex, health plan type, and geographic location (8). Inpatient and outpatient claims are captured along with the associated diagnosis (*International Classification of Diseases, 9th Revision* format), any procedures performed (Current Procedure Terminology [CPT], 4th edition format), and patient demographic information. Standard and mail order prescription information is also captured. The data are collected anonymously without individual patient identifiers in accordance with the Health Insurance Portability and Accountability Act. This project was certified as exempt from institutional review board review by the University of California, San Diego Human Research Protections Program.

Cases of SSNHL were identified for 2006 and 2007. Patients with a new claim associated with a diagnosis of sudden hearing loss (*International Classification of Diseases, 9th Revision*, 388.2) during the study period were counted as having the disorder. To be counted as a new case, they must not have had a previous claim for sudden hearing loss in the preceding 2 years. Those with other distinct diagnoses related to known causes of rapid hearing loss were excluded, such as Ménière's disease (386.0x), labyrinthine fistula (386.4x), noise-induced hearing loss (388.1x), congenital hearing loss (744.0x), and vestibular schwannoma (225.1). Results were projected to the entire U.S.-insured population (estimated at 249 million at the time of the study) using proprietary methodology.

The 95% confidence interval (CI) for proportions was calculated using the Wilson score method without continuity correction (9).

RESULTS

Over the 2-year period the estimated annual incidence of SSNHL was 27 per 100,000, with an average of 66,594 new cases per year among the U.S.-insured population. Looking at individual years, there was no difference in incidence (66,606 cases in 2006 and 66,582 cases in 2007, $p = 0.9476$, χ^2 test).

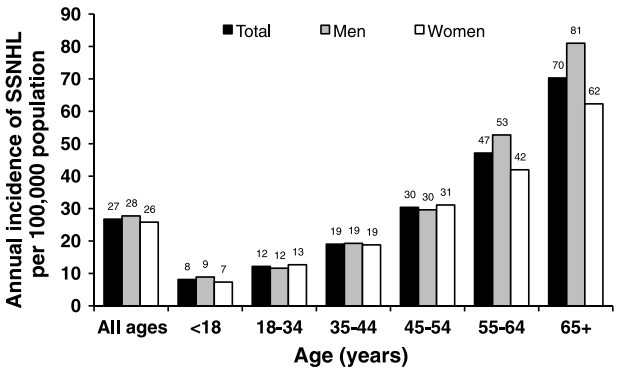

FIG. 1. Annual incidence of sudden hearing loss by age group and sex.

TABLE 1. *Percentage of patients receiving specified treatments for sudden hearing loss by year*

Treatment	2006 (%)	2007 (%)
Systemic corticosteroids alone	41.08	40.45
IT injection alone	1.19	1.24
Systemic corticosteroids and IT injection	2.24	4.32
Other or no treatment	55.49	53.99
	100.00	100.00

IT indicates intratympanic.

As shown in Figure 1, the incidence of SSNHL increased with increasing age. Overall, men were slightly more likely to be affected than women, with a male-to-female ratio of 1.07:1 (95% CI, 1.058–1.091). The sex difference was more pronounced in patients older than 65, with a male-to-female ratio of 1.30:1 (95% CI, 1.268–1.333).

Analysis of treatment data revealed that 44% of patients received a prescription for a systemic corticosteroid. Overall, 4.5% of patients were treated with intratympanic (IT) injection of medication (the specific type of medication injected was not available in the database). Additional treatment data by year are shown in Table 1. There was a statistically significant increase in the percent of patients treated with a combination of both systemic corticosteroids and IT injection in 2007, compared with 2006 ($p < 0.0001$, χ^2 test). The percentage of patients treated with neither systemic corticosteroids nor IT injection decreased significantly from 2006 to 2007 ($p < 0.0001$, χ^2 test). There were no clinically significant differences in treatment between women and men (not shown).

DISCUSSION

This study represents the first large population-based examination of the incidence of SSNHL in the United States. The estimated annual incidence of 27 per 100,000 corresponds to more than 66,000 new cases per year in the United States. For comparison, the incidence rates of selected otologic and nonotologic disorders are shown in Table 2.

Our search of the literature revealed only 3 other studies examining the incidence of SSNHL since Byl's oft-cited 1984 review. Teranishi et al. (5) reported results from a series of surveys sent to inpatient hospitals throughout Japan in 1972, 1987, 1993, and 2001 enquiring about the number of patients treated for SSNHL. The population served by the hospitals was used to estimate the nationwide incidence of the disorder. They reported an increase in incidence during the 30 years examined, with a final incidence of 27.5 per 100,000 in 2001, a number in close agreement with the incidence observed in the present study.

In a German language publication, Klemm et al. (4) reported the number of SSNHL cases treated by specialty physicians in Dresden in 2004. Using the population of Dresden as a denominator, they arrived at an incidence

TABLE 2. *Incidence of selected otologic and nonotologic disorders*

Condition	Annual Incidence per 100,000 population	Reference(s)
All hearing loss (in adults older than 48 yr)	4,200	(23)
Sudden hearing loss (present study)	27	N/A
Sudden hearing loss (previous studies)	4–160	(2,4–6)
Otosclerosis	6.1–13.7	(24,25)
Vestibular schwannoma	0.6–0.8	(26)
Purulent otitis media (in adults)	250	(27)
All cardiovascular disease	1,452	(28)
Stroke	269	(29)
Myocardial infarction	208	(30)

of 160 per 100,000. The authors speculated that the much higher incidence relative to previous reports was related in part to an increased awareness of SSNHL in Germany, improved record-keeping, increased health-care access, and a greater likelihood of patients seeking prompt treatment.

Wu et al. (6) examined the incidence of SSNHL in Taiwan from 1998 to 2002 using methodology similar to the present study. They examined data from the country's National Health Insurance program database capturing inpatient medical claims for the more than 20 million people. They found an annual incidence of 10.21 per 100,000 in 2002, a number that is lower than the incidence in the present study. This could represent a real difference in incidence between the United States and Taiwanese populations or could be due to differences in methodology. One potential reason for the difference could relate to the use of inpatient claims only in the study from Taiwan compared with both inpatient and outpatient claims in our study. According to the authors, all SSNHL patients in Taiwan are recommended to undergo inpatient treatment, whereas in the United States, most cases are treated as outpatients. It is possible that patients with milder hearing loss may be less willing to undergo inpatient admission for treatment, and presumably, they would have been excluded in the study from Taiwan. Our database should include all patients who sought care, regardless of setting.

The last previously published estimate in the United States came from the 1977 study by Byl (2). A series of 52 patients with idiopathic SSNHL treated in the Kaiser Foundation Health Plan in Northern California in 1973 were reported. Using the number of patients enrolled in the plan as the denominator, he arrived at an annual incidence of 10.7 per 100,000. It is unclear if the higher incidence seen in the present study reflects an actual change in the U.S. population or is due to methodologic differences such as the much smaller sample size in the Byl study. The studies from Taiwan and Japan did show increasing incidence over time (5,6).

Incidence of SSNHL increased with age in the present study, with 70 cases per 100,000 per year in those age 65 and older. Byl also found increasing incidence with increasing age, with a peak incidence of 47 per 100,000 in patients 65 years and older (3). Teranishi et al. reported a peak annual incidence of 58 per 100,000 in patients aged 60 to 64 in Japan, with a steep decline in incidence with increasing age above 65 years. Klemm et al. reported bimodal peaks at 40 to 49 years and 60 to 69 years in Germany (4). In the study from Taiwan, incidence steadily increased with age, with a peak of 23.15 per 100,000 in patients older than 70 years (6). Some of the differences between studies are likely related to the different cutoffs chosen for age groups.

Overall, men were slightly more likely to be affected in the present study, with a male-to-female ratio of 1.07:1, but a clear male preponderance emerged in the older age groups. Byl performed a limited ''meta-analysis'' of studies published before 1984 and identified 200 male and 191 female patients, giving a male-to-female ratio of 1.05:1, similar to that in the present study (3). The male-to-female ratio in Taiwan was reported as 1.14:1 (6). Interestingly, the German study by Klemm et al. (4) found an overall female preponderance with a female-to-male ratio of 1.22:1. The reason for this difference is unclear, but differences across cultures and sexes may affect the likelihood of an individual self-reporting an otologic condition (10).

Idiopathic SSNHL may be the result of multiple etiologies. The leading proposed causes include vascular events, viral infection, and autoimmune disorders (1,11). The increase in incidence of SSNHL with increasing age may point to differences in etiology in younger and older patients (6). Vascular events causing SSNHL may be more common in the elderly and in men because of their increased rates of underlying cardiovascular disease (12). Risk factors for cardiovascular thromboembolic disease have been shown to increase the risk of developing SSNHL (13), although temporal bone histopathology studies have not found evidence to support a vascular etiology (14). Population-specific incidence of causal factors could also explain differences in incidence reported in different countries.

Treatment of SSNHL remains somewhat controversial. Corticosteroids have been the mainstay of treatment for SSNHL since Wilson et al. (15) reported their potential benefit. However, a recent randomized, blinded, multicenter study found no improvement in hearing recovery in patients treated with oral prednisolone compared with a placebo group with no active treatment (16). There is mounting evidence, however, that the dosage of oral steroids may have some influence on the potential recovery in SSNHL in that if the concentration of steroids is high enough in the inner ear, the chances for recovery increase (17). This has led to the popularity of IT injections of corticosteroids, which have been shown to result in higher perilymph levels than systemic routes of administration (18,19). A multi-center, randomized controlled trial recently showed equivalent hearing recovery with IT methylprednisolone compared to oral prednisone (20). Other studies have suggested combined IT and systemic therapy may be superior or that IT steroids may offer a benefit as salvage therapy after failed systemic

therapy (21). In the present study, less than half of the patients were treated with systemic corticosteroids, and only a small minority was treated with intratympanic injection in 2006 and 2007. These findings contrast with the results of a practice survey in the United States indicating that 98% of otolaryngologists and 71% of general practitioners recommend corticosteroid treatment as initial therapy for SSNHL (22).

The use of medical claims data to examine the epidemiology of SSNHL offers the benefit of a large sample size. Almost 25% of the insured U.S. population were included in this study. However, there is susceptibility to bias that must be recognized when using medical claims data for epidemiologic studies. First and foremost, there is no guarantee that patients coded as having SSNHL actually meet accepted guidelines for clinical diagnosis. Furthermore, patients with the disorder who do not seek medical care will be missed.

In conclusion, the current estimate of the incidence of SSNHL in the United States is 27 per 100,000. It is slightly more likely to occur in men, and the incidence increases dramatically with increasing age.

REFERENCES

1. Chau JK, Lin JR, Atashband S, et al. Systematic review of the evidence for the etiology of adult sudden sensorineural hearing loss. *Laryngoscope* 2010;120:1011–21.
2. Byl FM. Seventy-six cases of presumed sudden hearing loss occurring in 1973: prognosis and incidence. *Laryngoscope* 1977; 87:817–25.
3. Byl FM Jr. Sudden hearing loss: eight years' experience and suggested prognostic table. *Laryngoscope* 1984;94:647–61.
4. Klemm E, Deutscher A, Mosges R. [A present investigation of the epidemiology in idiopathic sudden sensorineural hearing loss]. *Laryngorhinootologie* 2009;88:524–7.
5. Teranishi M, Katayama N, Uchida Y, et al. Thirty-year trends in sudden deafness from four nationwide epidemiological surveys in Japan. *Acta Otolaryngol* 2007;127:1259–65.
6. Wu CS, Lin HC, Chao PZ. Sudden sensorineural hearing loss: evidence from Taiwan. *Audiology & neuro-otology* 2006;11:151–6.
7. van Caneghem D. [Sudden deafness]. *Acta Otorhinolaryngol Belg* 1958;12:5–17.
8. *LifeLink Health Plan Claims Data User Guide & Data Dictionary [company brochure]*. Danbury, CT: IMS Health, 2009.
9. Newcombe RG. Two-sided confidence intervals for the single proportion: comparison of seven methods. *Stat Med* 1998;17: 857–72.
10. Havia M, Kentala E, Pyykko I. Prevalence of Meniere's disease in general population of Southern Finland. *Otolaryngol Head Neck Surg* 2005;133:762–8.
11. Beyea JA, Agrawal SK, Parnes LS. Recent advances in viral inner ear disorders. *Curr Opin Otolaryngol Head Neck Surg* 2012;20: 404–8.
12. Roger VL, Go AS, Lloyd-Jones DM, et al. Heart disease and stroke statistics—2012 update: a report from the American Heart Association. *Circulation* 2012;125:e2–220.
13. Lin RJ, Krall R, Westerberg BD, et al. Systematic review and meta-analysis of the risk factors for sudden sensorineural hearing loss in adults. *Laryngoscope* 2012;122:624–35.
14. Merchant SN, Adams JC, Nadol JB Jr. Pathology and pathophysiology of idiopathic sudden sensorineural hearing loss. *Otol Neurotol* 2005;26:151–60.
15. Wilson WR, Byl FM, Laird N. The efficacy of steroids in the treatment of idiopathic sudden hearing loss. A double-blind clinical study. *Arch Otolaryngol* 1980;106:772–6.
16. Nosrati-Zarenoe R, Hultcrantz E. Corticosteroid treatment of idiopathic sudden sensorineural hearing loss: randomized triple-blind placebo-controlled trial. *Otol Neurotol* 2012;33:523–31.
17. Egli Gallo D, Khojasteh E, Gloor M, et al. Effectiveness of systemic high-dose dexamethasone therapy for idiopathic sudden sensorineural hearing loss. *Audiol Neurootol* 2013;18:161–70.
18. Bird PA, Murray DP, Zhang M, et al. Intratympanic versus intravenous delivery of dexamethasone and dexamethasone sodium phosphate to cochlear perilymph. *Otol Neurotol* 2011;32:933–6.
19. Bird PA, Begg EJ, Zhang M, et al. Intratympanic versus intravenous delivery of methylprednisolone to cochlear perilymph. *Otol Neurotol* 2007;28:1124–30.
20. Rauch SD, Halpin CF, Antonelli PJ, et al. Oral vs intratympanic corticosteroid therapy for idiopathic sudden sensorineural hearing loss: a randomized trial. *JAMA* 2011;305:2071–9.
21. Spear SA, Schwartz SR. Intratympanic steroids for sudden sensorineural hearing loss: a systematic review. *Otolaryngol Head Neck Surg* 2011;145:534–43.
22. Shemirani NL, Schmidt M, Friedland DR. Sudden sensorineural hearing loss: an evaluation of treatment and management approaches by referring physicians. *Otolaryngol Head Neck Surg* 2009;140: 86–91.
23. Cruickshanks KJ, Tweed TS, Wiley TL, et al. The 5-year incidence and progression of hearing loss: the epidemiology of hearing loss study. *Arch Otolaryngol Head Neck Surg* 2003;129:1041–6.
24. Pearson RD, Kurland LT, Cody DT. Incidence of diagnosed clinical otosclerosis. *Arch Otolaryngol* 1974;99:288–91.
25. Levin G, Fabian P, Stahle J. Incidence of otosclerosis. *Am J Otol* 1988;9:299–301.
26. Propp JM, McCarthy BJ, Davis FG, et al. Descriptive epidemiology of vestibular schwannomas. *Neuro Oncol* 2006;8:1–11.
27. Pukander J, Luotonen J, Sipila M, et al. Incidence of acute otitis media. *Acta Otolaryngol* 1982;93:447–53.
28. National Institutes of Health. National Heart, Lung, and Blood Institute. Incidence and Prevalence: 2006 Chart Book on Cardiovascular and Lung Diseases. Available at: http://www.nhlbi.nih.gov/resources/docs/06a_ip_chtbk.pdf. Accessed May 31, 2013.
29. Williams GR. Incidence and characteristics of total stroke in the United States. *BMC Neurol* 2001;1:2.
30. Yeh RW, Sidney S, Chandra M, et al. Population trends in the incidence and outcomes of acute myocardial infarction. *N Engl J Med* 2010;362:2155–65.