Sudden Sensorineural Hearing Loss in Children: A Report of 75 Cases

Yi Qian, Shixun Zhong, Guohua Hu, Houyong Kang, Ling Wang, and Yan Lei

Department of Otorhinolaryngology, The First Affiliated Hospital of Chongqing Medical University, Chongqing City, China

Objective: To investigate the characteristics, treatment, and prognostic factors of sudden sensorineural hearing loss (SSNHL) in children.
Methods: Seventy-five cases (78 ears) of SSNHL in children from February 2011 to June 2016 were retrospectively analyzed. We scrutinized the clinical manifestations, audiological assessments, and serologic examinations of these pediatric cases by univariate and multivariate logistic analysis methods. The patients were divided into four groups according to their audiometric curve type: ascending, descending, flat, and profound.
Results: Of the 75 patients (78 ears), 25 patients were in the ascending group (32.00%), 9 patients were in the descending group (12.00%), 17 patients were in the flat group (22.67%), and 24 patients were in the profound group (32.32%). The overall recovery rates (complete + partial + slight) of the different groups were as follows: ascending group, 96.00%; flat group, 76.47%; profound group, 50.00%; and descending group, 44.44%. The overall recovery rate of all patients was 70.67%. The multivariate logistic analysis showed that the type of audiometric curve and the interval from onset to intervention were two independent risk factors that correlated with the prognosis of SSNHL in children. Some children had positive cytomegaoviyns, rubella virus, and herpes simplex virus immunoglobulin G antibodies. Twenty-one children were treated with additional intratympanic methylprednisolone as salvage therapy and 13 of these children showed improved (complete + partial + slight) recoveries. Three children had postauricular compound betamethasone injections, but none of them showed improvement. One of three children recovered slightly after treatment with intratympanic methylprednisolone combined with postauricular betamethasone injection.
Conclusions: The prognosis of SSNHL in children is closely related to the type of audiometric curve and the onset of treatment. Intratympanic methylprednisolone and compound betamethasone injected postauricularly could be effective for SSNHL in children. **Key Words:** Children—Drug therapy—Hearing loss—Intratympanic—Prognosis—Sudden.

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Sudden sensorineural hearing loss (SSNHL) is rare in children. It is an abrupt hearing loss of more than 30 dB that affects at least three consecutive frequencies with no identifiable cause (1). The optimum period for speech and language development in children is between the ages of 1 and 6 years; therefore, without immediate treatment, SSNHL can cause serious disorders such as permanent hearing loss and can severely affect children's speech and cognitive development, resulting in psychiatric sequelae that increase the burden on families and society.

SSNHL indicates an abnormality of the cochlea, auditory nerve, or higher aspects of central auditory perception or processing. Up to 90% of SSNHL is idiopathic at presentation and is presumptively attributed to vascular, viral, immunizing, or multiple etiologies (2). Approximately, 32 to 65% of patients with SSNHL recover spontaneously (3,4).

The definitive etiology of SSNHL is unknown, and its treatment is thus controversial. Many studies report therapy options such as systemic and topical steroids, antiviral agents, diuretics, and hyperbaric oxygen treatments for adults. The prognosis for recovery depends on a number of factors including, patient age; presence of vertigo at onset; degree of hearing loss; audiometric

configuration; and the time between the onset of hearing loss and treatment (5,6). The pathogenesis of SSNHL with various audiometric curves may be different. Treatment options should be based on the audiometric configuration.

Many studies have investigated the causes, treatments, and prognostic factors of SSNHL in adults, but few studies on children have been reported because of the low incidence of SSNHL in this population. Current guidelines for SSNHL diagnosis and treatment are proposed for adults. The lack of standardization in approaches to the diagnosis and treatment of SSNHL in children leaves them vulnerable to the most efficacious therapy during a critical window of their lives. Pediatric literatures on children have discussed only the benefits of oral steroids in a small number of patients, and the data on intratympanic or postauricular steroid administration are lack (7,8).

We retrospectively analyzed the data of 75 cases of SSNHL in children to study the clinical characteristics, efficacy, treatment, and prognostic factors associated with different audiometric configurations.

METHODS

Patient Populations

We performed a retrospective study of 75 patients (78 ears) suffering from SSNHL who were below 18 years of age and were hospitalized in the Department of Otorhinolaryngology at the First Affiliated Hospital of Chongqing Medical University from February 2011 to June 2016.

We obtained the written and informed consent of all the children and their parents. Our investigation was approved by the local ethics review board and was performed in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

We initially reviewed all patients who had a diagnosis of SSNHL. The inclusion criteria were as follows:

1) age below 18 years;
2) no history of hearing loss for themselves or their family;
3) diagnosis of SSNHL according to the criteria defined in ''Clinical Practice Guideline: Sudden Hearing Loss''(1);
4) absence of ear disorders not related to sudden onset hearing loss, including middle ear disease, retro-cochlear disorders, auditory neuropathy, and large vestibular aqueduct syndrome;
5) No non-organic hearing loss or genetic, congenital deafness confirmed by genetic screening or neonatal hearing screening;
6) No pathology demonstrated by any imaging studies (computed tomography/magnetic resonance imaging).

Audiology Assessment

The level of hearing loss was measured by pure-tone audiometry, and tympanometry was performed on all patients to exclude disorders of the middle ear. To evaluate the vestibular function of all the children, nystagmographic registration of spontaneous nystagmus, a bithermal caloric test, optokinetic nystagmus, gaze test, oculardysmetria test, smooth pursuit test, and apositioning test were performed.

Intratympanic and Postauricular Steroid Administration

Before the procedure, an informed consent was signed with a clear explanation of the different injection sites, the risks and benefits. The operative procedure of intratympanic steroid injection was performed under a microscope and with patient in supine position. After the surgeon confirmed the intact tympanic membrane and middle ear status, topical anesthesia was administered with injection of 0.1 ml lidocaine (10%). While the patient tilted the head 45 degrees to the healthy side, a 25-gauge spinal needle was introduced into the antero-inferior portion of membrane and 0.4 ml of methylprednisolone (40 mg/ml). This procedure was performed five times, once every 2 days. The patient was instructed to avoid swallowing or moving for 30 minutes, keeping in the same position to provide maximal absorption of the medication through the round window. These children were also asked to keep their ears dry and clean to avoid infection.

Postauricular steroid injection was administrated for the children who refused intratympanic injection because of fear 1 ml betamethasone was injected subperiosteally at upper half of retroauricular groove at mastoid. A single injection was recommended for each patient.

Classification of SSNHL

Four types of SSNHL were defined according to their audiogram shape: ascending, descending, flat, and profound.

The ascending group included patients whose average hearing threshold at 0.25 to 0.5 kHz was 20 dB higher than that at 4 to 8 kHz. The audiogram shape was described as descending when the average hearing threshold at 4 to 8 kHz was 20 dB higher than at 0.25 to 0.5 kHz. The flat type of SSNHL referred to patients whose threshold was observed across the entire frequency range and the hearing threshold did not exceed 80 dB HL. For patients with a flat audiogram and a hearing threshold of over 80 dB, the audiogram shape was classified as profound.

The Degree of Hearing Loss

The degrees of hearing loss were categorized as mild (26–40 dB HL), moderate (41–60 dB HL), severe (61–80 dB HL), and profound hearing loss (>80 dB HL).

Treatment

All patients were treated with the ginkgo leaf extract dipyridamole (calculated per kilogram of body weight) injected intravenously every day for 7 to 14 days, prednisone 1 mg/kg orally once a day in the morning for 3 days, and alprostadil (calculated per kilogram of body weight) once a day for 7 to 14 days. The patients in the flat and profound groups had an additional intravenous injection of batroxobin (calculated per kilogram of body weight) every alternate day. Once the patients' hematic fibrinogen levels decreased to less than or equal to 0.5 g/L, the batroxobin therapy was withdrawn. Additional intratympanic methylprednisolone was administered in 21 children, and a compound betamethasone injection was administered postauricularly in three patients. Three children were treated with both intratympanic methylprednisolone and postauricular betamethasone.

Treatment Outcomes

The treatment outcomes were categorized as follows: complete recovery—final hearing was improved to a normal or pretreatment level; partial recovery—a hearing improvement of more than 30 dB HL; slight recovery—a hearing improvement of 15 to 30 dB HL; no recovery— a hearing improvement of less than 15 dB HL.

The overall recovery rate was calculated with following formula: (Complete recovery + Partial recovery + Slight recovery)/(Complete recovery + Partial recovery + Slight recovery + No recovery) × 100%.

Statistical Analysis

After examining the variance equivalence and normal distribution, we applied univariate and multivariate logistic analyses to analyze the prognostic factors of SSNHL in children. Parameters that were statistically significant in the univariate logistic analysis were included in the multivariate logistic analysis. Table 1 lists the factors related to the therapy outcomes of SSNHL and their levels. All statistical processing was conducted with SPSS version 16.0 for Windows (IBM, Armonk, NY). A p value of <0.05 was considered to be statistically significant.

RESULTS

Demographics

Seventy-five SSNHL patients who were under 18 years of age were evaluated in this study. Thirty-eight patients were men and 37 patients were women. The age of the children ranged from 9 to 18 years, and the mean age was 15.74 years. Of the 75 children, 72 (96%) had hearing loss in one ear, including 40 (53.33%) in the right ear and 32 (42.67%) in the left ear. Three children (4.00%) had hearing loss in both ears. Patients arrived at the hospital for treatment at an average of 11.13 days after hearing loss onset, which ranged from 6 hours to 6 months. At their first visit, mild, moderate, severe, or profound hearing loss was observed in 24 (32.00%), 16 (21.33%), 10 (13.33%), and 25 children (33.33%), respectively. The overall recovery rate of the children with mild, moderate, severe, and profound hearing loss was 79.17, 87.50, 70.00, and 52.00%, respectively. Of the four defined types of audiogram curves, 25 patients (33.33%) were classified as ascending, 9 patients (12.00%) as descending, 17 patients (22.67%) as flat, and 24 patients (32.00%) as profound. The overall recovery rate of the children in the ascending, descending, flat, and profound groups was 96.00, 44.44, 76.47, and 50.00%, respectively. Complete recovery was found in 32 of the 75 children (42.67%). Eight patients' treatment outcomes were classified as partially recovered

TABLE 1. *Characteristics and recovery rate of children (sex, age, degree of hearing loss, audiogram curves type, affected ear, onset of treatment, tinnitus, vertigo, aural fullness, BPPV, tiredness, influenza)*

		No Recovery Rate	Overall Recovery Rate	
		Case (%)	Case (%)	Total
Gender	Male	13 (34.21%)	25 (65.79%)	38
	Female	9 (24.32%)	28 (75.68%)	37
Age	≤12 years	4 (57.14%)	3 (42.86%)	7
	13–18 years	18 (26.47%)	50 (73.53%)	68
Degree of hearing loss	Mild	5 (20.83%)	19 (79.17%)	24
	Moderate	2 (12.50%)	14 (87.50%)	16
	Severe	3 (30.00%)	7 (70.00%)	10
	Profound	12 (48.00%)	13 (52.00%)	25
Audiogram curves type	Ascending	1 (4.00%)	24 (96.00%)	25
	Descending	5 (55.56%)	4 (44.44%)	9
	Flat	4 (23.53%)	13 (76.47%)	17
	Profound	12 (50.00%)	12 (50.00%)	24
Affected ear	Right	9 (22.50%)	31 (77.50%)	40
	Left	11 (34.38%)	21 (65.63%)	32
	Bilateral	2 (66.67%)	1 (33.33%)	3
Onset of treatment	≤7 days	11 (19.30%)	46 (80.70%)	57
	8–14 days	6 (54.55%)	5 (45.45%)	11
	15 days	5 (71.43%)	2 (28.57%)	7
Tinnitus	No	7 (50.00%)	7 (50.00%)	14
	Yes	15 (24.59%)	46 (75.41%)	61
Vertigo	No	12 (22.64%)	41 (77.36%)	53
	Yes	10 (45.45%)	12 (54.55%)	22
Aural fullness	No	12 (26.09%)	34 (73.91%)	46
	Yes	10 (34.48%)	19 (65.52%)	29
BPPV	No	20 (28.17%)	51 (71.83%)	71
	Yes	2 (50.00%)	2 (50.00%)	4
Tiredness	No	20 (28.99%)	49 (71.01%)	69
	Yes	2 (33.33%)	4 (66.67%)	6
Influenza	No	21 (31.82%)	45 (68.18%)	66
	Yes	1 (11.11%)	8 (88.89%)	9

BPPV indicates benign paroxysmal positional vertigo.

(10.67%), 12 patients were slightly recovered (16.00%), and 23 patients had no recovery (30.67%).

The overall recovery rate of the children was 70.67%. Tinnitus was the most common concomitant symptom and experienced by 61 (81.33%) patients, followed by aural fullness (n = 29, [38.67%]), and vertigo (n = 22, [29.33%]). Four patients suffered from benign paroxysmal positional vertigo (BPPV). Six patients (8.00%) reported a history of tiredness, and nine patients (12.00%) had influenza before their sudden hearing loss occurred (Table 1).

Positive cytomegaoviyns (CMV) immunoglobulin G (Ig G) antibodies were detected in 12 children, rubella virus Ig G antibodies in 10 children, and herpes simplex virus Ig G antibodies in 10 children. Twenty-one children were treated with additional intratympanic methylprednisolone as a salvage therapy, and 13 of these children showed improvement (complete + partial + slight recovery). The parents of three children rejected intratympanic injection therapy, and no child in the group who had postauricular compound betamethasone injections showed any recovery at all. One of three children recovered slightly following intratympanic methylprednisolone combined with postauricular betamethasone injections. The imaging studies of the temporal bones, including enhanced computed tomography/magnetic resonance imaging scans, showed that none of the patients suffered from any pathology. One of the patients had experienced recurrence of SSNHL 2 months after the first completely recovery.

Two children complained of temporary otalgia and vertigo after their intratympanic therapy, but no severe complications, such as perforation of the tympanic membrane, occurred. The patients' pain was greatly eased when lidocaine was added to their intratympanic methylprednisolone therapy.

The Univariate Logistic Regression Analysis of Possible Prognostic Factors

On the basis of their hearing recovery, the patients were divided into two groups: hearing recovery and no recovery, and the data are shown in Table 1. We analyzed 12 univariates: sex; age; degree of hearing loss; audiogram curves type; affected ear; onset of treatment; tinnitus; vertigo; aural fullness; BPPV; tiredness; and influenza. Our results showed that the audiometric curve type (p value: 0.012) and onset of treatment (p value: 0.006) were two independent risk factors correlated with the efficacy of therapies for SSNHL in children (Table 2).

The Multivariate Logistic Regression Analysis of Possible Prognostic Factors

Parameters that yielded a p value of <0.05 in the univariate analysis were included in the multivariate analysis. We, therefore, selected audiometric curve type and onset of treatment for multivariate analysis. Our results indicated that audiometric curve type (p value: 0.013), and onset of treatment (p value: 0.021) were related to the efficacy of therapies for SSNHL in children (Table 3).

DISCUSSION

SSNHL is a serious ailment and its treatment should be considered as a matter of emergency. It has a wide age distribution with a peak at 50 to 60 years of age (7). Little is known about its prevalence, etiology, treatment, and prognostic factors in children. Chen et al. (8) report that SSNHL affects one child in 10,000 in Germany. A number of studies report that 6.6 to 10.9% of SSNHL patients are under 18 years of age (7–9). Our study identifies 75 children with SSNHL, which accounts for 3.55% of all patients (2,113 cases) with SSNHL who were treated in our hospital between February 2011 and June 2016. The incidence of SSNHL in the children in our study is lower than that in literatures (9,10).

It has been reported that SSNHL demonstrates that the frequency of SSNHL is similar in males and females (10,11). The population in the present study consisted of 38 boys (50.67%) and 37 girls (49.33%), which also confirm that the frequency of SSNHL is similar in men and women, regardless of their age at onset.

TABLE 2. *The univariate logistic regression analysis of risk factors*

Variate	EV	SE	Wald	p	OR	OR(95% CI)
Gender	0.481	0.514	0.877	0.349	1.618	0.591–4.427
Age	1.309	0.812	2.602	0.107	3.704	0.755–18.179
Degree of hearing loss	1.255	0.855	6.665	0.083	3.508	0.996–12.359
Audiogram curves type	−3.401	1.221	10.956	0.012[a]	0.033	0.003–0.365
Affected ear	−0.590	0.531	2.927	0.231	0.554	0.196–1.569
Onset of treatment	−1.613	0.692	10.355	0.006[a]	0.199	0.051–0.774
Tinnitus	1.121	0.612	3.356	0.067	3.067	0.925–10.170
Vertigo	−1.046	0.539	3.762	0.052	0.351	0.122–1.011
Aural fullness	−0.400	0.515	0.602	0.438	0.671	0.244–1.841
BPPV	−0.936	1.034	0.819	0.365	0.392	0.052–2.977
Tiredness	−0.203	0.906	0.050	0.823	0.816	0.138–4.818
Influenza	1.317	1.093	1.452	0.228	3.733	0.438–31.808

BPPV indicates benign paroxysmal positional vertigo; CI, confidence interval; EV, estimated value; OR, odds ratio; SE, standard error.
[a]Means $p < 0.05$.

TABLE 3. *The multivariate logistic analysis of risk factors*

Variate	EV	SE	Wald	p	OR	OR(95% CI)
Audiogram curves type	−3.523	1.304	10.816	0.013	0.029	0.002−.380
Onset of treatment	−1.254	0.793	7.764	0.021	0.285	0.060−1.351

CI indicates confidence interval; EV, estimated value; OR, odds ratio; SE, standard error.

SSNHL has been shown to occur at similar frequencies in the right and left ears, with the unilateral type being much more common than in the bilateral type, although the latter has been observed in 4 to 17% of patients with sudden sensorineural hearing loss (8). Na et al. (9) reported the incidence of bilateral type SSNHL is 8.1% in children. In Li's (10) reports, 19.9% of hearing loss in children were of the bilateral type. Tarshish et al. (12) found bilateral hearing loss in 9/20 (45%) children. In our study, 72 children (96%) had SSNHL in one ear, including 40 children (53.33%) in the right ear, 32 (42.67%) in the left ear, and three children (4.00%) in both ears.

Although many studies have investigated the causes of SSNHL, no definitive mechanism has been established, and furthermore, these studies have not addressed this condition in children. In the literatures that focus on adult cases, SSNHL is often considered to be related to cardiovascular risk factors such as smoking, alcohol consumption, and hyperlipidemia. Virus infection is the most common cause of SSNHL in children (9), particularly CMV and Epstein-Barr virus infections. Lyme disease, also known as Lyme borreliosis, has also been reported as a rare cause of SSNHL (11). In our study, positive CMV Ig G antibodies were detected in 12 children, rubella virus Ig G antibodies in 10 children, and herpes simplex virus Ig G antibodies in 10 children.

Investigators have proposed that viremia delivers viruses to the inner ear through the striavascularis that performs an important role in the fluid homeostatic and metabolic functions of the inner ear. CMV infection can directly infect hair cells and cause loss of these crucial and post mitotic cell populations. The inflammatory response to inner ear CMV infection results in both immediate and delayed damage to hair cells, and the inner ear in general (13). However, no data are available to clarify whether these patients had a congenital CMV/RV/herpes simplex virus infection. Furthermore, because their imaging results are normal, it is not possible to directly relate their hearing loss to a viral infection. Currently, the role of viral infection in SSNHL remains unclear and the use of antiviral medications remains controversial, even when CMV/RV/herpes simplex virus antibodies have been detected in patient serum.

All the children in our study were treated with oral steroids for 3 days. Twenty-one children were treated with additional intratympanic methylprednisolone as a salvage therapy, 13 of these children showed improvement (complete + partial + slight) in hearing. No child who had postauricular compound betamethasone injections showed recovery, and one of three children recovered slightly after treatment with intratympanic methylprednisolone combined with postauricular betamethasone injections. The children treated with postauricular compound betamethasone injections as a salvage therapy did not show recovery. Two of these children had the profound type of audiogram and one of them had the descending type, which probably indicates that the descending and profound audiogram shape types are negative prognostic factors; two children had profound hearing loss, and one child had mild hearing loss. Some younger children were too scared to have intratympanic injections, and they could have been treated with postauricular approaches, which could be effective. Two of these children complained of otalgia after their intratympanic therapy, but no severe complications such as perforation of the tympanic membrane occurred. The young patients tolerated their intratympanic therapy much better when lidocaine was added to their methylprednisolone injections.

Systemic steroids are recommended for the treatment of SSNHL in American guidelines, and intratympanic steroid therapy is considered to be second line or salvage therapy. Although the guidelines are proposed for patients over 18 years of age, literatures have reported that systemic steroids are also the first choice for children with SSNHL. Some studies on intratympanic steroid treatment for idiopathic SSNHL after the failure of intravenous therapy demonstrate that the salvage therapy offers potential benefits (14–16). Salvage therapy provide localized treatment with higher perilymphatic concentrations and avoids systemic side effects. Some of the disadvantages include otalgia during and after treatment, persistent tympanic membrane perforation, vertigo, dysgeusia, and potential infection. There are reports on systemic steroid treatment in children, but there is no sufficient data on intratympanic steroid administration in this age group. There are only two studies on intratympanic steroid administration in children. One was performed by Pitaro et al. (17), who investigates 8/19 children who received intratympanic steroids salvage therapy, five had partial hearing recovery, and three did not improve. Dedhia and Chi (18) reviewed 20 children with SSNHL, of which two patients underwent intratympanic steroid therapy and both showed improvement. Oral steroid combined with intratympanic injection is discussed in literatures. The authors also propose that combination therapy is better than single drug (19,20).

The postauricular injection of steroid was recently used in clinical practice to treat inner ear diseases on

the basis of the assumed existence of a direct channel from the postauricular area to the inner ear. Yang et al. (21) report that the postaurical single injection of beta-methasone is more effective in treating intractable low frequency sensorineural hearing loss than oral adminis-tration for 2 weeks. Subsequently, postaurical injection of steroid was also used to treat sudden sensorineural hearing loss and tinnitus. Potential existence of a direct transportation channel from the postaurical area to the inner ear was reported to support the postaurical injection approach. Postaurical injection reportedly induced greater distribution of gadolinium chelate in the inner ear of guinea pigs than intravenous injection (22). Com-pound betamethasone injection is a kind of long-acting corticosteroid, which includes 2 mg betamethasone sodium phosphate and 5 mg betamethasone dipropionate per milliliter and is used extensively in clinical settings. Betamethasone sodium phosphate can exert its effect rapidly due to strong solubility and quick hydrolysis. In contrast, betamethasone dipropionate can be absorbed slowly to maintain a long time of effect. Thus, postaurical administration may represent a potential alternative drug delivery route, with the conceivable advantages of rea-sonable therapeutic effect, minimal invasiveness, sim-plicity, minimal damage to the middle ear, and relative freedom from influence by the blood−labyrhth barrier.

At final pure tone audiometry after treatment, we found that 53 children showed recovery (complete + partial+ slight), and the overall recovery rate was 70.67%. The rate of recovery from SSNHL in children varies between studies, and ranged from 20 to 80% due to different evaluation criteria in the literatures and differ-ent treatment regimes. Therefore, more studies are needed to elaborate on the rate of recovery from SSNHL in children. It should perform the same evaluation criteria worldwide for the outcome.

In the present study, ''ascending'' type hearing loss and early treatment were determined to be positive prognostic factors of hearing recovery according to univariate and multivariate logistic regression analysis. The better prognosis of the '' ascending'' type may be related to its possible pathogenesis of endolymphatic hydrops, which is sensitive to medicine, and the poor prognosis of the ''descending'' type may be related to its possible pathogenesis of hair cell damage (1). The trav-eling wave theory proposes that the high frequency zone is at the basal cochlea where the metabolic rate is higher than that in the other parts (1). The region with high metabolic rate could be more vulnerable to insufficient blood supply, and thus hearing recovery is poorer. There-fore, we propose that it is necessary to treat SSNHL in children on the basis of the audiometric curve.

The present study showed children who were treated within 14 days from onset had much better prognosis than those treated over 14 days from onset (p value <0.05). However, the recovery rate of children treated within 7 days from onset compared with that treated from 8 to 14 days of onset was similar (p value >0.05). This finding indicates that 14 days may be an important time

node for the treatment of SSNHL. Shiraishi et al. (23) also reported that the best improvement could be obtained for those treated within 7 days from onset. SSNHL may be difficult to detect in children, especially at a young age with unilateral hearing loss. It is, however, still worthy to treat the patients with a longer course. Improvement has been reported in patients with a longer history of even more than 6 months (24).

We found the prognosis is not related to children's sex, age, degree of hearing loss, affected ear, tinnitus, vertigo, aural fullness, BPPV, tiredness, and influenza. Although several studies have found that the recovery rate is associated with patient age, i.e., younger patients have better outcomes (8). In some studies, the authors concluded that vertigo is a negative factor and tinnitus is a positive factor for recovery from SSNHL. Li et al. (10) performed a study of 136 children with SSNHL and suggested that unilateral hearing loss and early treatment were positive prognostic factors of hearing recovery, but the initial severe hearing loss, tinnitus, ascending type audiogram, and sex were negative prognostic factors. Age, vertigo, and ear fullness were found to be independent of recovery.

One of the children in our study had relapse after 3 months, the child had the ascending audiogram type and showed no recovery, but had completely recovered at the first onset. Park et al. (25) reported 11 of 809 patients studied had recurrent idiopathic SSNHL, hearing recovery was poorer after a recurrent episode than that after the first episode.

In conclusion, SSNHL in children is rare. Viral infec-tion may play a role in etiology. Systemic steroids are recommended for the treatment of SSNHL in children. Intratympanic methylprednisolone and compound beta-methasone injected postauricularly could be effective for SSHNL in children. Timely treatment within 14 days and the ascending audiogram type are positive prognostic factors. Further studies should be randomized double-blind multicenter control studies to establish standardi-zation of diagnosis and management pathways.

REFERENCES

1. Stachler RJ, Chandrasekhar SS, Archer SM, et al. Clinical practice guideline: sudden hearing loss. *Otolaryngol Head Neck Surg* 2012;146 (3 suppl):S1−35.
2. Rauch SD. Clinical practice. Idiopathic sudden sensorineural hear-ing loss. *N Engl J Med* 2008;359:833−40.
3. Mattox DE, Simmons FB. Natural history of sudden sensorineural hearing loss. *Ann Otol Rhinol Laryngol* 1977;86 (4 pt 1):463−80.
4. Conlin AE, Parnes LS. Treatment of sudden sensorineural hearing loss: II. A meta-analysis. *Arch Otolaryngol Head Neck Surg* 2007;133:582−6.
5. Fetterman BL, Saunders JE, Luxford WM. Prognosis and treatment of sudden sensorineural hearing loss. *Am J Otol* 1996;17:529−36.
6. Conlin AE, Parnes LS. Treatment of sudden sensorineural hearing loss: I. A systematic review. *Arch Otolaryngol Head Neck Surg* 2007;133:573−81.
7. Michel O. [The revised version of the german guidelines ''sudden idiopathic sensorineural hearing loss'']. *Laryngorhinootologie* 2011;90:290−3.

8. Chen YS, Emmerling O, Ilgner J, Westhofen M. Idiopathic sudden sensorineural hearing loss in children. *Int J Pediatr Otorhinolaryngol* 2005;69:817–21.

9. Na SY, Kim MG, Hong SM, Chung JH, Kang HM, Yeo SG. Comparison of sudden deafness in adults and children. *Clin Exp Otorhinolaryngol* 2014;7:165–9.

10. Li FJ, Wang DY, Wang HY, et al. Clinical Study on 136 children with sudden sensorineural hearing loss. *Chin Med J* 2016;129:946–52.

11. Chung JH, Cho SH, Jeong JH, Park CW, Lee SH. Multivariate analysis of prognostic factors for idiopathic sudden sensorineural hearing loss in children. *Laryngoscope* 2015;125:2209–15.

12. Tarshish Y, Leschinski A, Kenna M. Pediatric sudden sensorineural hearing loss: diagnosed causes and response to intervention. *Int J Pediatr Otorhinolaryngol* 2013;77:553–9.

13. Schleiss MR, Choo DI. Mechanisms of congenital cytomegalovirus-induced deafness. *Drug Discov Today* 2006;3:105–13.

14. Davis GL, Spector GJ, Strauss M, Middlekamp JN. Cytomegalovirus endolabyrinthitis. *Arch Pathol Lab Med* 1977;101:118–21.

15. Spear SA, Schwartz SR. Intratympanic steroids for sudden sensorineural hearing loss: a systematic review. *Otolaryngol Head Neck Surg* 2011;145:534–43.

16. Wen YH, Chen PR, Wu HP. Prognostic factors of profound idiopathic sudden sensorineural hearing loss. *Eur Arch Otorhinolaryngol* 2014;271:1423–9.

17. Pitaro J, Bechor-Fellner A, Gavriel H, Marom T, Eviatar E. Sudden sensorineural hearing loss in children: etiology, management, and outcome. *Int J Pediatr Otorhinolaryngol* 2016;82:34–7.

18. Dedhia K, Chi DH. Pediatric sudden sensorineural hearing loss: etiology, diagnosis and treatment in 20 children. *Int J Pediatr Otorhinolaryngol* 2016;88:208–12.

19. Gundogan O, Pinar E, Imre A, Ozturkcan S, Cokmez O, Yigiter AC. Therapeutic efficacy of the combination of intratympanic methylprednisolone and oral steroid for idiopathic sudden deafness. *Otolaryngol Head Neck Surg* 2013;149:753–8.

20. Seggas I, Koltsidopoulos P, Bibas A, Tzonou A, Sismanis A. Intratympanic steroid therapy for sudden hearing loss: a review of the literature. *Otol Neurotol* 2011;32:29–35.

21. Yang XQ, Yu LS, Ma X. [Postaurical injection of compound betamethasone to treat the intractable low-frequency sensorineural hearing loss]. *Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi* 2007;42:814–6.

22. Li J, Yu L, Xia R, Gao F, Luo W, Jing Y. Postauricular hypodermic injection to treat inner ear disorders: experimental feasibility study using magnetic resonance imaging and pharmacokinetic comparison. *J Laryngol Otol* 2013;127:239–45.

23. Shiraishi T, Kubo T, Okumura S, et al. Hearing recovery in sudden deafness patients using a modified defibrinogenation therapy. *Acta Otolaryngol Suppl* 1993;501:46–50.

24. Yeo SW, Lee DH, Jun BC, Park SY, Park YS. Hearing outcome of sudden sensorineural hearing loss: long-term follow-up. *Otolaryngol Head Neck Surg* 2007;136:221–4.

25. Park IS, Kim YB, Choi SH, Hong SM. Clinical analysis of recurrent sudden sensorineural hearing loss. *ORL J Otorhinolaryngol Relat Spec* 2013;75:245–9.