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Research Article

A Cross-Sectional Survey Evaluating Awareness of Congenital Cytomegalovirus Among Audiologists and Speech-Language Pathologists

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Purpose: Congenital cytomegalovirus (cCMV) is the most common congenital infection worldwide and a leading environmental cause of pediatric hearing loss (HL). The objective of this study was to evaluate audiologists and speech-language pathologists (SLPs) on awareness and knowledge of cCMV.
Method: A multiple-choice survey assessing awareness, knowledge, and practice patterns was sent electronically to audiologists and SLPs of the American Speech-Language-Hearing Association. Results were compared between audiologists and SLPs and within stratified groups of audiologists. Data were collected, and descriptive analysis was performed.
Results: Ninety-four audiologists and 317 SLPs responded. Most audiologists were somewhat or very familiar with cCMV (85.9%), while only 26% of SLPs responded that they were at least somewhat familiar with cCMV ($p < .0001$). When comparing audiologists' and SLPs' knowledge of symptoms, transmission, and diagnostic age for cCMV, audiologists had higher scores in all categories ($p < .0001$). Audiologists were then stratified into subgroups to evaluate the association of the given subgroup with their overall knowledge. The more advanced audiology training, the more knowledgeable the respondent was regarding HL progression ($p = .002$). Audiologists who were more familiar with cCMV scored better in most categories compared to those reporting somewhat or less familiar; these findings were only significant for knowledge of symptoms ($p < .0001$). Audiologists who were sometimes or frequently evaluating children less than 5 years of age had a better understanding of HL presentation among cCMV patients than those who rarely saw this patient population. Those who were in practice for < 20 years frequently knew the time-sensitive age of diagnosis than respondents in practice longer.
Conclusions: As a leading environmental cause of pediatric HL, cCMV is frequently encountered by audiologists and SLPs. This study highlights knowledge gaps and areas where targeted education is needed for both groups.

The most common worldwide congenital infection is congenital cytomegalovirus (cCMV), with an estimated prevalence ranging from 0.5% to 1.7% of all newborns (Baer et al., 2014; Foulon et al., 2012, 2008; Kenneson & Cannon, 2007). Most immunocompetent individuals who contract CMV are asymptomatic or have only common cold symptoms. Contact saliva from young children is the most likely route for pregnant women to acquire CMV. Infants who acquire CMV in utero are at risk for the sequelae of cCMV; this distinction is best made through diagnostic testing before the first 3 weeks of life.

cCMV is considered symptomatic if a child has one or more clinical signs or associated disorders of CMV, including microcephaly, small for gestational age or intrauterine growth restriction, hepatosplenomegaly (enlarged liver and spleen), petechiae and/or purpura (small red or purple spots caused by bleeding into the skin), jaundice, evidence of central nervous system involvement (microcephaly, hypotonia, seizures), and hearing loss (HL). Ten percent of children are symptomatic. However, those with asymptomatic cCMV have a 10%–15% chance of developing sensorineural

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HL (SNHL; Fowler, 2013). In fact, cCMV is the leading cause of environmental HL, approximately 15%–35% of infants with bilateral moderate-to-profound loss are due to cCMV (Grosse et al., 2008; Morton & Nance, 2006). Because CMV is not a part of the recommended universal newborn screening panel, cCMV frequently goes undiagnosed as children often do not show visible signs of disease (Schleiss, 2018).

Despite cCMV being the most common cause of environmental HL and a significant cause of morbidity in infants, there is limited awareness of cCMV in both individuals in the community and medical providers. Data from the 2015–2016 HealthStyles survey reported a 7% cCMV awareness rate (5% for men and 9% for women; Doutre et al., 2016). Globally, awareness rates vary between 9% and 22% in the literature among women of childbearing age (Fowler & Boppana, 2018). Although there is higher awareness among medical professionals, there are still significant knowledge gaps regarding CMV transmission and clinical outcomes. We previously evaluated awareness among pediatric otolaryngologists and otologists and found that, although 100% stated they were familiar with this condition, these gaps were also associated with underutilization of hearing targeted (HT) screening for cCMV. HT screening is a process where children who fail the newborn hearing screen are evaluated for cCMV within the first 3 weeks of life, regardless of whether they have clinical symptoms (Diener et al., 2017). Most did not incorporate CMV testing into their practice and were not familiar with the appropriate diagnostic tools or the time-sensitive nature for diagnosing this condition (Dedhia et al., 2019). Studies evaluating provider knowledge in the Netherlands and France also found poor knowledge of CMV transmission routes and cCMV symptoms (Cordier et al., 2012; Korver et al., 2009). Recently, Muldoon et al. (2017) looked at awareness among physical and occupational therapists and found that, while 52% of participants self-reported awareness of cCMV, only 18% demonstrated understanding of the behavioral modes of transmission. The knowledge gap between self-reported familiarity and health risk knowledge of cCMV has implications for the health of practitioners and patients.

Given poor levels of cCMV awareness and even lower demonstrated understanding of cCMV transmission, outcomes, and management reported in the literature in both the community and medical field, we sought to evaluate awareness among audiologists and speech-language pathologists (SLPs). Audiologists and SLPs are in frequent contact with children who have HL and/or other disabilities, such as developmental language disorders (which may additionally be complicated by other comorbidities). They are very likely to have a number of children with cCMV on their caseload. Some children with cCMV may have an established diagnosis, while most will not. Recent studies demonstrate improvement or stabilization of hearing with early treatment of cCMV, and it is known that early therapeutic interventions have improved long-term developmental outcomes (Kimberlin et al., 2015). One of the major issues associated with cCMV focuses on the dynamic properties of the infection. The American Speech-Language-Hearing Association (ASHA) protocol recommends a hearing sensitivity evaluation prior to beginning speech and language therapy. That one-time, preintervention assessment of hearing is not adequate for cCMV because of the possibility of late onset or progression of HL. In addition, cCMV has the capability of compromising vision, potentially creating a dual sensory loss situation requiring a significant change in therapeutic strategy. In contrast to simple developmental language delay, cCMV involvement creates the need for coordinated interdisciplinary diagnostic, intervention, and treatment regimens. It is imperative that audiologists and SLPs are aware of cCMV and its management in order to advocate for appropriate testing, treatment, and services for their patients. In this article, we report the results of a cCMV awareness survey conducted among audiologists and SLPs.

Method

The Emory University Institutional Review Board granted approval for this study (IRB 00092913). We performed a cross-sectional survey in both audiologists and SLPs. A survey was sent electronically to audiologist and SLP members of ASHA on two separate occasions (see the Appendix). The survey was open to audiologists from September 14 to October 15, 2018, and SLPs received the survey February 28 to March 21, 2019. The original solicitation was sent to audiologists on September 14 via two audiology lists, the general audiology list of 1,046 audiologists and a pediatric audiology list of 773 audiologists. The speech pathology cohort was solicited via an SLP list consisting of 4,012 members. A reminder notice was sent to members of each discipline 2 weeks and again at 1 week before the respective surveys closed.

There were three main components to the survey: demographics, knowledge of cCMV, and practice patterns. The following demographic variables were addressed: gender, age, race, ethnicity, highest degree, exposure to cCMV education, years of experience, work with children less than 5 years of age, practice environment, percentage of patients evaluated for HL in their practice, and whether or not they had children. The questionnaire assessed familiarity with conditions associated with HL, knowledge of CMV transmission, and overall knowledge of cCMV, including the following: signs and associated diagnoses, prevalence, effect on and presentation of HL, audiologic management, and cCMV diagnosis. The last portion queried the current management of cCMV at the individual's institution. Provider familiarity was assessed on the 4-point scale presented in our survey. We followed Muldoon et al. (2017) and considered participants who answered "very familiar" or "somewhat familiar" to the question "How familiar are you with the following conditions?" to have self-reported familiarity with each condition.

The questions assessing knowledge of cCMV symptoms and CMV transmission included both correct and incorrect answer choices. The respondent chose between the

following responses: yes, no, and I do not know. When analyzing the findings, if the answer was "no" or "I do not know" when the answer should have been "yes," that was coded as being not correct. In the case where the answer was "yes" or "I do not know" and should have been "no," this was coded as not being correct. This approach allowed us to have a better estimate of true knowledge. We analyzed the total score correct, which included the total number for which the respondent stated that a correct answer was correct and an incorrect answer was incorrect. For questions assessing disease incidence, progression, diagnosis, and management, we used a combination of the above method and multiple-choice questions. Frequency responses to all questionnaire items were determined, and overall score percentages were calculated per questionnaire item. The overall score was based on the sum of correctly stated true answers, assigning 1 point per correct answer.

Responses to questions evaluating the global understanding of cCMV were compared between audiologists and SLPs. Furthermore, we stratified audiologists and compared scores based on the following: academic degree, years in practice, practice attributes, having children, and type of practice. Given that SLPs had low self-reported familiarity scores on the initial survey, we did not include a stratified analysis within this group.

Statistical analysis was performed in Stata Version 16. We used nonparametric (Wilcoxon rank sum and Kruskal–Wallis) tests for all comparisons, with Bonferroni corrections for multiple comparisons.

Results

Demographics of Respondents

ASHA has more than 208,000 members who work in a variety of professional settings. In order to focus on SLPs most likely to see children, we coordinated with an ASHA staff member who specializes in surveys to send solicitation of survey participation to SLP members who self-identified as providing pediatric services. Solicitation of audiology survey participation was accomplished by sending notices through the audiology general community electronic mailing list (n = 1,046) and a pediatric community electronic mailing list (n = 773).

A total of 94 audiologists and 317 SLPs completed the survey (see Table 1). Of the 4,012 SLP recipients, three e-mail invitations were undeliverable, and 10 individuals opted out of the survey, leaving 3,999 eligible participants, with an overall 7.9% response rate for SLPs. Because there is an overlap between the two audiology community electronic mailing list, we were not able to calculate the total recipients, those who opted out, e-mail solicitations not deliverable, or an overall response rate. A majority of respondents, both audiologists and SLPs, were women, with an average age of 49 years (range: 26–79) for audiologists and 45 years (range: 25–77) for SLPs. Overall, most respondents were White and not of Hispanic or Latino ethnicity. A majority of audiologists (74%) had a degree that was higher than Master of Arts/Master of Science, compared to 6% of SLPs. Forty percent of SLPs and 54% of audiologists had been in practice for more than 20 years. A majority of the respondents from both groups infrequently (≤ 25% of caseload) saw patients with pediatric SNHL (audiologists: 57.3%, SLPs: 94.5%). Eleven percent of audiologists and 58% of SLPs indicated that they had no caseload of individuals with SNHL. However, over half of the respondents in each group worked with children less than 5 years of age.

Knowledge of cCMV Compared to Other Conditions and of Its Effect on Hearing

Eighty-six percent of audiologists were at least somewhat familiar with cCMV, compared to only 26% of SLPs (see Figure 1). In fact, audiologists answered they were more familiar with most pediatric disorders, except for Down syndrome, which in that case showed similar knowledge compared to that of SLPs (see Table 2). More than 40% of SLPs recognized HL (56%), intellectual disability (47%), and motor disabilities (41%) as clinical outcomes of cCMV but were not very familiar with other disorders associated with cCMV. Audiologists, on the other hand, were familiar with most associated disorders, with the exception of petechia and purpura (22%), splenomegaly (29%), hepatomegaly (35%), and death (40%). There were six listed disorders that were not associated with cCMV, and most respondents either answered they did not know if there was an association or that they were not cCMV symptoms (see Table 3). Most SLPs did not know the frequency of HL among asymptomatic or symptomatic cCMV patients or that cCMV is the most common environmental cause of HL. Only 60% of audiologists answered that cCMV is the most common environmental cause of HL, and less than half knew the incidence of cCMV in symptomatic and asymptomatic cases (see Table 4). Overall, audiologists were more familiar with cCMV incidence compared to SLPs ($p < .0001$).

A majority of audiologists knew that HL in cCMV patients can present as progressive or stable; however, less were aware that it may also be fluctuating (see Table 5; Fowler, 2013; Fowler et al., 1997). There was limited knowledge regarding the percentage of cCMV-infected children who develop progressive HL (30%). Forty percent of audiologists would perform audiograms on children with cCMV every 6 months, increasing to 3 months if hearing change was identified. Approximately 20% would perform audiograms every 3 months with increasing frequency in children where HL is identified, while relatively few would perform testing at 3-month, 6-month, or yearly intervals without a change in hearing. Eleven percent were unsure of the correct follow-up frequency for testing.

Knowledge of cCMV Diagnosis and Transmission

Only 51% of audiologists and 13.5% of SLPs correctly knew that a critical time exists for the definitive diagnosis of cCMV, with 26.7% of audiologists and 75.7% of SLPs reporting that they did not know when that critical time ends

Table 1. Demographics.

Characteristic	Audiologists (*N* = 94)		Speech pathologists (*N* = 317)	
Age	*M* = 48.8 years *SD* = 11.7 range: 26–79 *N* = 94		*M* = 44.8 years *SD* = 12.1 range: 25–77 *N* = 311	
	Respondents (*n*)	**%**	**Respondents (*n*)**	**%**
Gender				
Female	83	88.3	295	94.3
Male	10	10.6	12	3.8
Prefer not to answer	1	1.1	6	1.9
Race				
American Indian or Alaska Native	0	0	1	0.3
Asian	1	1.1	4	1.3
Black or African American	0	0.0	9	2.9
Native Hawaiian or other Pacific Islander	0	0.0	0	0.0
White	87	93.5	267	85.8
Mixed race	1	1.1	5	1.6
Prefer not to answer	4	4.3	25	8.0
Ethnicity				
Hispanic or Latino	2	2.2	14	5.0
Not Hispanic or Latino	85	94.4	238	85.6
Prefer not to answer	3	3.3	26	9.4
Highest degree				
MA/MS	24	25.8	291	93.9
Higher than MA/MS	69	74.2	19	6.2
Years in practice				
0–5	8	8.6	38	12.3
6–10	9	9.7	61	19.7
11–15	12	12.9	58	18.7
16–20	14	15.1	29	9.4
> 20	50	53.8	124	40.0
% of practice with SNHL				
None	10	11.2	178	58.2
1–25	41	46.1	111	36.3
26–50	14	15.7	6	2.0
51–75	8	9.0	2	0.7
> 75	16	18.0	9	2.9
Work with children < 5 years old				
Never	6	6.9	60	19.5
Rarely	11	12.6	51	16.6
Sometimes	19	21.8	43	14.0
Often	34	39.1	89	29.0
Always	17	19.5	64	20.9
Children				
Yes	52	69.3	177	70.0
No	23	30.7	76	30.0

Note. MA/MS = Master of Arts/Master of Science; SNHL = sensorineural hearing loss.

(see Figure 2). At least 50% of audiologists were familiar with five out of six correct routes of transmission for CMV compared to only a 20%–30% of SLPs (see Table 6). There were four incorrect transmission routes listed in the survey, which most respondents in both groups either correctly responded "no" or responded "I do not know." Overall, audiologists were more familiar with diagnosis and transmission routes of cCMV compared to SLPs ($p < .0001$).

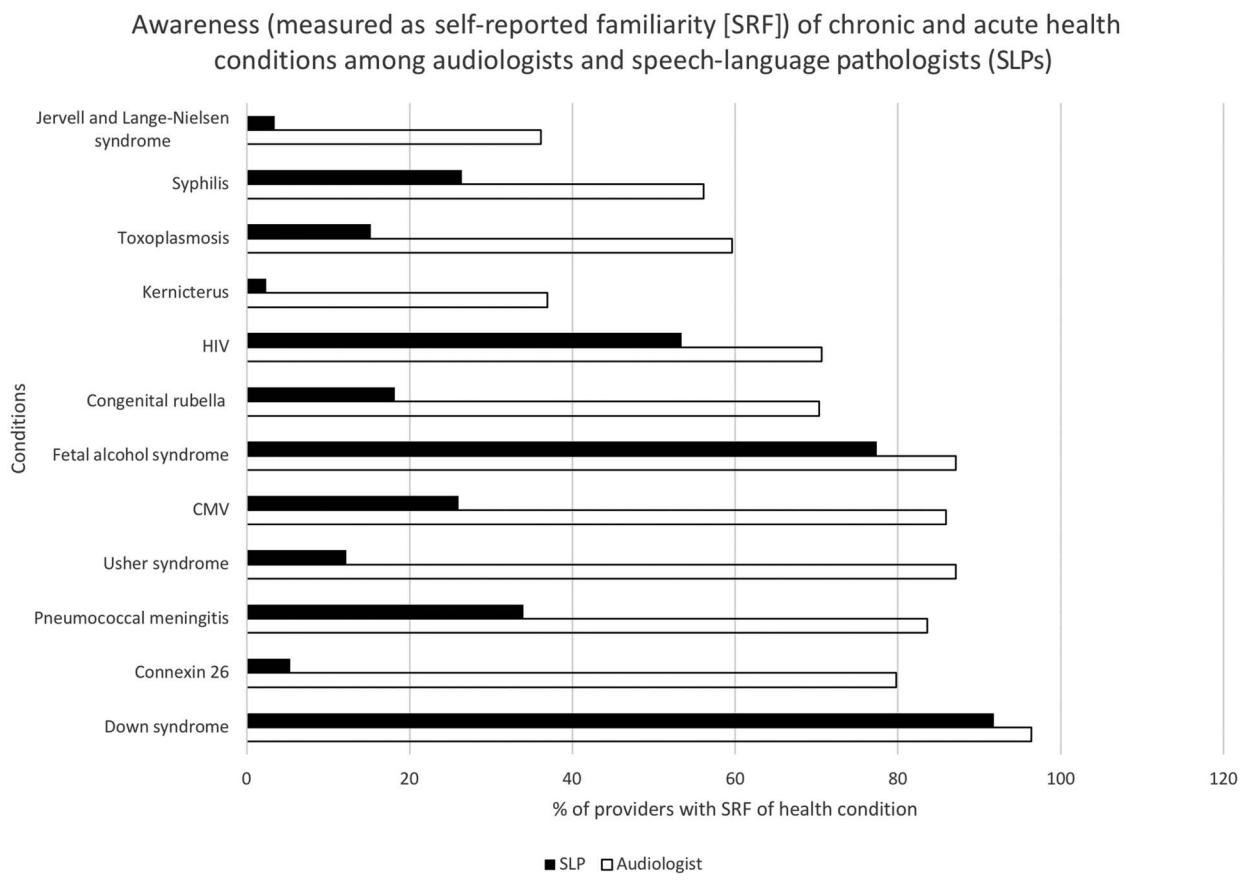
Source of cCMV Information

Forty-four percent of SLPs received education regarding cCMV through their primary care provider and 25% from their OB-GYN visits (see Table 7). They did not report any education through their speech graduate programs in the "other" category, while audiologists learned about cCMV from their audiology graduate programs (47%). Furthermore, most respondents reported that they did not have either targeted or universal cCMV screening at their facility or that they did not know if it is available (see Figure 3).

Comparison Among Stratified Audiology Groups

We compared the median scores within each stratified group of audiologists (see Table 8). Overall, most participants across all groups had their best scores with questions

Figure 1. Self-reported familiarity with health conditions. CMV = cytomegalovirus.



geared toward cCMV transmission and HL presentation. The percentage of the practice associated with pediatric SNHL, having children at home, and type of practice were not associated with cCMV knowledge. Audiologists whose practice consisted of 26%–75% patients with pediatric SNHL were more likely to correctly identify the age for definitive diagnosis ($p = .0065$). Audiologists who reported practicing for < 20 years were also more knowledgeable about transmission routes compared to providers in practice for a longer time ($p = .0056$). Having a higher degree and reporting

Table 2. Familiarity with diseases impacting pediatric patients.

	Audiologist (%)					Speech pathologist (%)					
Disease	**Not familiar**	**Slightly familiar**	**Somewhat familiar**	**Very familiar**	**Total *N***	**Not familiar**	**Slightly familiar**	**Somewhat familiar**	**Very familiar**	**Total *N***	***p***
Congenital cytomegalovirus	1.2	12.9	45.9	40.0	85	46.9	27.1	19.1	6.9	303	**.0001**
Congenital rubella	3.6	26.2	42.9	27.4	84	58.0	23.8	15.2	3.0	302	**.0001**
Connexin 26 mutation	7.1	13.1	36.9	42.9	84	91.3	3.3	2.3	3.0	299	**.0001**
Down syndrome	0.0	3.5	23.5	72.9	85	1.3	6.9	26.1	65.7	303	.154
Fetal alcohol syndrome	0.0	12.9	50.6	36.5	85	4.3	18.3	37.2	40.2	301	**.603**
HIV	2.4	27.1	44.7	25.9	85	14.2	32.3	33.3	20.1	303	**.003**
Jervell and Lange-Nielsen syndrome	37.4	26.5	26.5	9.6	83	88.7	8.0	2.7	0.7	301	**.0001**
Kernicterus	38.1	25.0	16.7	20.2	84	91.4	6.3	1.7	0.7	303	**.0001**
Pneumococcal meningitis	0.0	16.5	42.4	41.2	85	18.8	47.2	24.1	9.9	303	**.0001**
Syphilis	11.0	32.9	41.5	14.6	82	32.0	41.6	19.5	6.9	303	**.0001**
Toxoplasmosis	9.5	31.0	44.1	15.5	84	57.1	27.7	10.2	5.0	303	**.0001**
Usher syndrome	0.0	12.9	47.1	40.0	85	64.7	23.1	7.6	4.6	303	**.0001**

Note. Bold values indicate statistical significance.

Table 3. Congenital cytomegalovirus symptoms.

Symptom	Audiologist (%)			Total *N*	Speech pathologist (%)			Total *N*
	Yes	No	Do not know		Yes	No	Do not know	
Correct symptoms								
Death	40.5	24.1	35.4	79	22.7	13.9	63.4	273
Hearing loss	100.0	0.0	0.0	81	56.4	1.5	42.2	275
Hepatomegaly	35.4	5.1	59.5	79	14.8	1.1	84.1	271
Intellectual disability	79.0	4.9	16.1	81	47.3	2.9	49.8	273
Intrauterine growth restriction	55.7	7.6	36.7	79	26.2	3.0	70.9	271
Microcephaly	61.5	7.7	30.8	78	31.9	2.6	65.6	273
Motor disabilities	75.3	6.2	18.5	81	41.0	2.9	56.0	273
Vision loss	72.8	6.2	21.0	81	28.5	4.4	67.2	274
Splenomegaly	29.1	3.8	67.1	79	8.5	3.7	87.8	271
Petechia and purpura	21.5	7.6	70.9	79	7.4	3.3	89.3	271
Seizures	51.3	3.9	44.9	78	31.3	1.5	67.3	272
Incorrect symptoms								
Limb malformation	8.8	43.8	47.5	80	11.1	9.6	79.3	270
Patent ductus arteriosus	5.1	16.5	78.5	79	5.2	4.1	90.8	271
Spina bifida	3.8	38.8	57.5	80	5.2	15.2	79.6	270
Thyroid dysfunction	13.8	17.5	68.8	80	7.0	5.6	87.4	270
Ventricular septal defect	13.9	17.7	68.4	79	9.2	4.8	86.0	271
Vocal cord paralysis	6.3	22.5	71.3	80	5.9	11.4	82.7	271
Total correct responses $p < .0001$	*Mdn* = 35% (*SD* = 25%)				*Mdn* = 6% (*SD* = 21%)			

higher familiarity with cCMV were the two factors that were more commonly associated with better cCMV knowledge. Higher degree was associated with higher likelihood of correctly answering most of the questions in relation to cCMV; however, statistical significance was only reached for the question regarding progressive HL incidence ($p = .002$). Those reporting that they were very familiar with cCMV outperformed respondents who were at most somewhat familiar in all categories; statistical significance was reached only for questions regarding symptoms ($p < .0001$).

Discussion

cCMV is the most common environmental cause of HL; however, based on our results, providers who should be intimately involved in the care of these patients demonstrated limited knowledge of this virus. This finding has been reported for many different medical providers, but not until now for audiologists and SLPs. Within our cohort, most audiologists were at least somewhat familiar with cCMV compared to SLPs. All audiologists were aware that HL is a symptom, and an overwhelming majority knew microcephaly, motor disabilities and vision loss, and intellectual disability are associated with cCMV. Overall, audiologists' performance was on par with what is described in the literature among other medical providers (Cordier et al., 2012; Dedhia et al., 2019; Korver et al., 2009; Muldoon et al., 2017). However, within the SLP cohort, slightly over half knew that HL was a symptom, and relatively few knew of other associated symptoms. These results are concerning for SLPs as they are also intimately involved in the care of patients with HL by performing speech services.

Similarly, SLPs had very limited knowledge regarding transmission routes of CMV. These findings among SLPs

Table 4. Congenital cytomegalovirus (cCMV) incidence.

Incidence	Audiologist (%)			Total *N*	Speech pathologist (%)			Total *N*
	Yes	No	Do not know		Yes	No	Do not know	
Up to 15% of children with asymptomatic cCMV can develop hearing loss.	**32.9**	**34.3**	**32.9**	**73**	**10.9**	**5.0**	**84.1**	**258**
Up to 75% children with symptomatic cCMV will develop hearing loss.	**46.0**	**23.0**	**31.1**	**74**	**9.7**	**5.4**	**84.9**	**259**
cCMV is the most common environmental cause of pediatric hearing loss.	**59.7**	**9.1**	**31.2**	**77**	**13.0**	**7.6**	**79.4**	**262**
Up to 30% of children with asymptomatic cCMV can develop hearing loss.	38.7	28.0	33.3	75	9.3	6.2	84.6	259
Up to 95% of children with symptomatic cCMV will develop hearing loss.	24.3	47.3	28.4	74	5.0	8.9	86.1	259
Total correct response $p < .0001$	*Mdn* = 20% (*SD* = 32%)				*Mdn* = 0% (*SD* = 18%)			

Note. Correct responses are in bold.

Table 5. Congenital cytomegalovirus (cCMV) hearing loss (HL) presentation and audiology management.

Variable	Response (%)			Total *N*
	Yes	No	Do not know	
HL presentation				
Stable	**74.0**	**16.9**	**9.1**	**77**
Progressive	**95.0**	**2.5**	**2.5**	**80**
Fluctuating	**54.6**	**19.5**	**26.0**	**77**
% of progressive HL	**%**		**Total *N***	
5	1.3		1	
20	6.6		5	
35	18.4		14	
50	**30.3**		**23**	
Do not know	43.4		33	
Frequency of audiogram for cCMV patient				
Every 3 months	12.2		9	
Every 6 months	5.4		4	
Every 3 months, increased to monthly if hearing change is identified	20.3		15	
Every 6 months, increase to 3 months if hearing loss identified	40.5		30	
Yearly, increase to 6 months if hearing loss identified	10.8		8	
Do not know	10.8		8	

Note. Correct responses are in bold.

are much lower than what has been reported in the literature among other medical professionals who may come in contact with children with cCMV. In a recent evaluation of CMV transmission knowledge by physical and occupational therapists, at least 40% were knowledgeable regarding most forms of transmission, which is higher than what was reported among speech therapists in our cohort (Muldoon et al., 2017). Audiologists, on the other hand, correctly reported transmission routes over half the time, with the exception of sexual intercourse (48%). Unfortunately, 66.7% also reported sneeze or cough as being a transmission route, which is incorrect. This misinterpretation of transmission routes can impact access to care for these patients. Providers may incorrectly assume they need to have the personal protective equipment for droplet precautions. When personal protective equipment for droplet precautions is not available,

Figure 2. Age for congenital cytomegalovirus (cCMV) definitive diagnosis. SLP = speech-language pathologist.

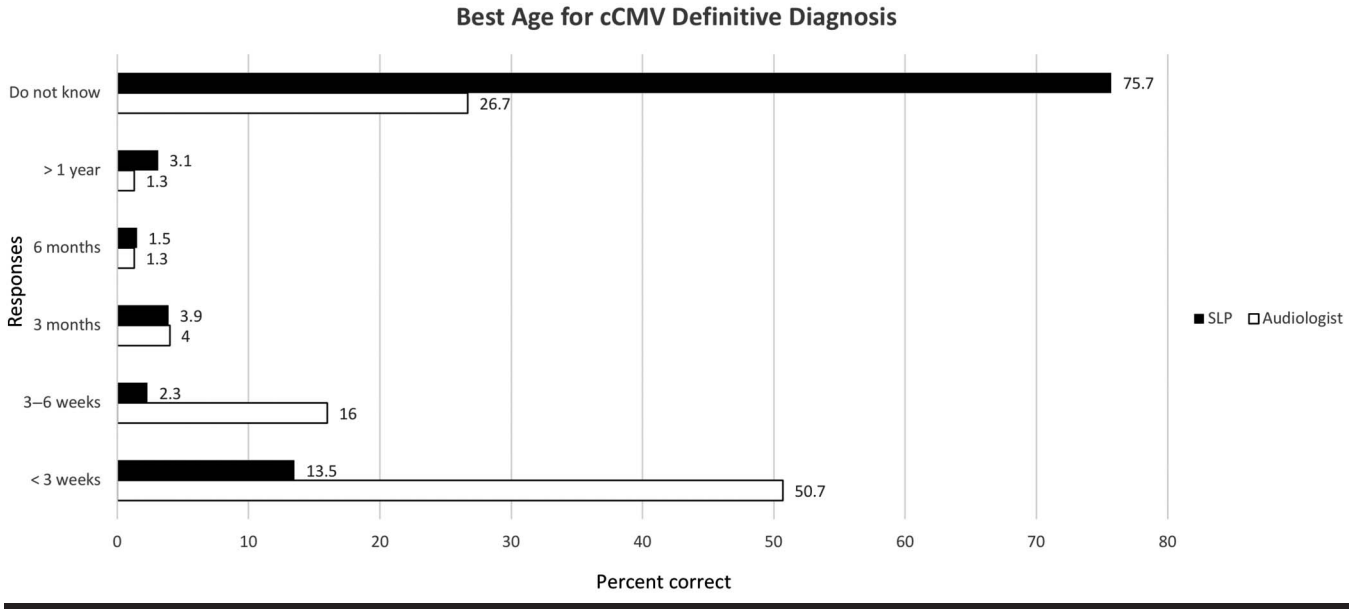


Table 6. Cytomegalovirus transmission routes.

Transmission route	Audiologist (%)			*N*	Speech pathologist (%)			*N*
	Yes	No	Do not know		Yes	No	Do not know	
Correct transmission route								
Blood transfusion	56.8	21.6	21.6	74	29.4	5.2	65.3	248
Breast milk	51.4	25.7	23.0	74	24.3	8.8	66.9	251
Changing diapers	59.5	23.0	17.6	74	19.4	15.0	65.6	247
Kissing	66.7	21.3	12.0	75	24.5	12.9	62.7	249
Sexual intercourse	48.0	30.1	21.9	73	23.1	10.5	66.4	247
Sharing food with children	61.3	21.3	17.3	74	21.9	12.4	65.7	251
Incorrect transmission route								
Sneeze/cough	66.7	17.3	16.0	74	24.2	11.5	64.3	252
Cat litter	13.5	70.3	16.2	74	15.5	19.1	65.5	246
Eating unpasteurized food	5.4	70.3	24.3	74	3.6	23.5	72.9	247
Ingestion of undercooked meat	5.4	74.3	20.3	74	3.7	24.4	72.0	246
Total correct $p < .0001$	*Mdn* = 60% (*SD* = 35%)				*Mdn* = 0% (*SD* = 29%)			

they may opt not to manage these patients, which in turn reduces access to care. Only contact precautions are recommended for CMV. No droplet precautions are needed (Rawlinson et al., 2017).

Furthermore, although all audiologists knew HL was a symptom of cCMV, they were less familiar with the characterization and incidence of HL. Just over half answered that cCMV was the most common cause of environmental HL, but less were familiar with the actual incidence among asymptomatic and symptomatic patients. There was adequate knowledge regarding HL presentation, with the exception of fluctuating, which only 55% correctly answered. However, although 95% of audiologists knew that children with cCMV can present with progressive loss, only 30% reported knowing the risk for a cCMV-infected child to develop progressive loss. This gap in knowledge is concerning since many families may seek an audiologist for counseling and information regarding their child's HL.

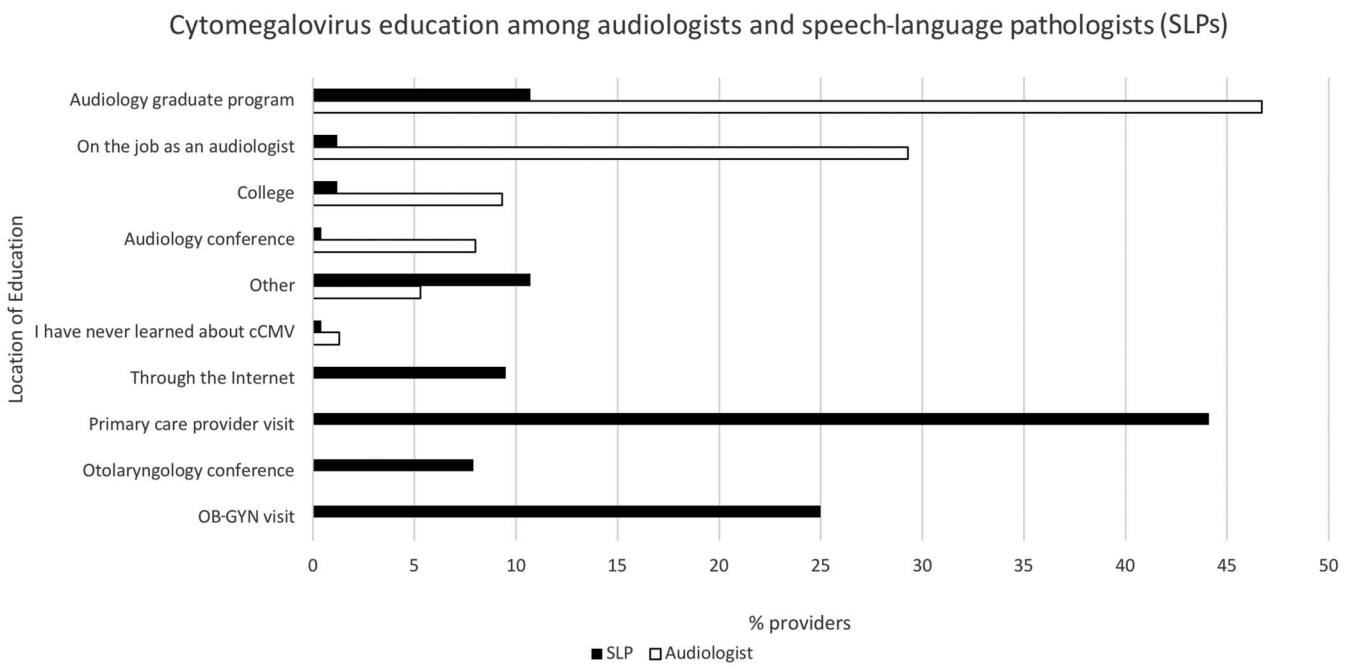
In addition, our survey revealed a considerable variability in their response to follow-up frequency. The disparate responses may reflect the lack of consensus within the literature. The 2019 Joint Committee on Infant Hearing Position Paper uses the word "periodic" for repeat screening. Multiple sources recommend testing every 6 months and then transitioning to annually after 3–5 years. No direction is given regarding increasing frequency of follow-up if HL is detected (Dietrich & Schieffelin, 2019; Fowler, 2013; Rawlinson et al., 2017). Fowler (2013) has suggested 3-month intervals for the first year or until the child is talking. Dietrich and Schieffelin (2019) recommend every 3–6 months for the first year, every 6 months until 3 years of age, and every 12 months until 6 years of age, if the viral load increases during therapeutic drug treatment.

One of the most concerning findings in our study was the lack of knowledge regarding the timing of diagnosis for cCMV. There is a critical window to diagnose newborns with cCMV, and that is within the first 3 weeks of life. After this time period, one must rely on the newborn dried blood spots. Unfortunately, dried blood spots testing is currently not an optimal test due to its relatively low sensitivity, its lack of availability (some health departments dispose of the Guthrie cards by 3 months of life), and the potential for DNA degradation over time. Audiologists fared better on this question with approximately 51% correctly answering this question, while only 14% of SLPs did so. Seventy-eight percent of SLPs and 27% of audiologists answered that they did not know. Although audiologists performed similarly on this question compared to our previous survey of otolaryngologists, there is still a high number of providers with limited knowledge about the critical aspect of cCMV diagnosis (Dedhia et al., 2019).

Table 7. Congenital cytomegalovirus (cCMV) screening availability.

Response	Audiologist		Speech pathologist	
	%	*n*	%	*n*
Does your institution or hospital offer hearing targeted early cCMV screening?				
Yes	18.9	14	4.4	11
No	48.7	36	40.9	103
Do not know	32.4	24	54.8	138
Does your institution or hospital offer universal cCMV screening?				
Yes	12.7	9	2.8	7
No	53.5	38	33.3	84
Do not know	33.8	24	63.9	161

Figure 3. Cytomegalovirus education. cCMV = congenital cytomegalovirus.



Furthermore, both audiologists and SLPs reported a low number of HT or universal cCMV screening available at their particular institution. In both cases, a significant number did not know if these screening programs existed within their given institution. The low percentage of testing availability is similar to what we previously reported among otolaryngologists (Dedhia et al., 2019). Currently, there are no consensus guidelines for screening in children with asymptomatic cCMV. Utah, Iowa, Illinois, New York, Connecticut, and Virginia have all passed legislation mandating HT screening, while others are considering such action (National CMV Foundation, n.d.). Given the high likelihood of HL progression in children with cCMV and HL, a screening program allows children to be identified earlier and closely followed. Since both SLPs and audiologists may often be the first providers to see these children, they are instrumental in advocating for testing these infants within the critical window, especially where HT or universal cCMV screening is not offered.

This disparity in cCMV knowledge between audiologists and SLPs may relate to the variation of CMV education. SLPs overwhelmingly learned nothing about CMV in their academic training programs. Instead, their learning took place when they sought personal medical care from an obstetrician or from their primary care physician. In general, our survey results for the SLPs were similar to a survey of women from the general population who were not health care providers (Jeon et al., 2006).

In contrast, almost half (46.7%) of the audiology respondents reported having didactic training on CMV. Another 29% learned about CMV once they entered the professional world as part of their clinically related experiences. Between the two sources of information (didactic and experience), the majority of audiologists had a working knowledge of cCMV and most of the associated disorders. In fact, our results revealed that audiologists with both an audiology degree and an additional degree were more knowledgeable about cCMV compared to their counterparts; this may be due to the increased exposure to this topic within their graduate courses.

Other factors associated with increased knowledge among audiologists included years in practice, reported cCMV familiarity, and percentage of practice associated with pediatric SNHL. Interestingly, one would assume that audiologists who saw a higher number of patients with SNHL would perform better than others. However, this result was not confirmed in our study. Those audiologists who evaluated 26%–75% of SNHL overall in their practice outperformed the other groups. Also, providers who practiced 11–20 years were more likely to perform better than those with less or more experience. These findings may be a result of acquiring more knowledge on the course of the job, along with recent knowledge attained during the pursuit of a graduate degree. Finally, as expected, audiologists who stated they were very familiar with cCMV tended to perform better on the survey.

A key limitation to our study was the self-selection and self-reporting of audiologists with regard to their knowledge level and experience with children affected by CMV. Our sample size was relatively low, especially among audiologists. In addition to the inherent bias of self-reported data, our survey may overestimate self-reported familiarity

Table 8. Comparison of congenital cytomegalovirus (cCMV) knowledge among audiology groups.

Characteristic	*n*	Median symptom score (%)	Median CMV hearing loss presentation score (%)	Median CMV hearing loss incidence (%)	Median hearing loss progression score (%)	Median age of definitive diagnosis score (%)	Median cCMV transmission score (%)
% of practice associated with pediatric SNHL							
0–25	51	35.3	66.7	33.3	0 (*n* = 45)	**0 (*n* = 45)**	60 (*n* = 51)
26–75	22	41.2	66.7	66.7	0 (*n* = 17)	**100 (*n* = 16)**	60 (*n* = 22)
> 75	16	41.2	66.7	50	0 (*n* = 13)	**0 (*n* = 13)**	50 (*n* = 16)
p		.37	.67	.56	.99	**.0065**	.65
Frequency of evaluating children < 5 years in practice							
Frequently/always	51	35.3	66.7	33.3	0 (*n* = 39)	100 (*n* = 38)	70 (*n* = 51)
Sometimes	19	35.3	66.7	66.7	0 (*n* = 17)	100 (*n* = 17)	60 (*n* = 19)
Rarely/never	17	41.2	33.3	33.3	0 (*n* = 12)	0 (*n* = 12)	50 (*n* = 17)
p		.82	.0485	.49	.48	.34	.31
Highest degree							
MA/MS	24	26.5	66.7	33.3	**0 (*n* = 19)**	50 (*n* = 18)	60 (*n* = 24)
AUD	40	41.2	66.7	33.3	**0 (*n* = 32)**	50 (*n* = 32)	60 (*n* = 40)
AUD + additional degree	29	52.9	66.7	100	**100 (*n* = 25)**	100 (*n* = 25)	50 (*n* = 29)
p		.03	.67	.02	**.002**	.99	.61
Years in practice							
0–10	17	29.4	66.7	33.3	0 (*n* = 13)	100 (*n* = 12)	**60 (*n* = 17)**
11–20	26	41.2	66.7	33.3	0 (*n* = 22)	100 (*n* = 22)	**70 (*n* = 26)**
> 20	50	35.3	66.7	33.3	0 (*n* = 41)	0 (*n* = 41)	**50 (*n* = 50)**
p		.23	.94	.8	.71	.021	**.0056**
Have children at home							
No	23	41.2	66.7	66.7	0	0	60
Yes	52	41.2	66.7	66.7	0	100	60
p		.66	.99	.25	1	.28	.54
Type of practice							
Nonacademic	59	35.3	66.7	33.3	0 (*n* = 48)	0 (*n* = 59)	60
Academic	36	41.2	66.7	66.7	0 (*n* = 28)	100 (*n* = 36)	60
p		.25	.48	.56	.59	.88	.87
cCMV familiarity							
Somewhat or less familiar	61	**29.4**	66.7	33.3	0 (*n* = 44)	0	60
Very familiar	34	**52.9**	66.7	66.7	0 (*n* = 32)	100	60
p		**.0001**	.02	.02	.054	.89	.73

Note. Significant values are in bold. SNHL = sensorineural hearing loss; MA/MS = Master of Arts/Master of Science; AUD = audiology.

with cCMV. Following Muldoon et al. (2017), we accounted for the effect of social desirability bias on self-reported data by evaluating demonstrated understanding of CMV transmission, as well as clinical management of HL.

Conclusions

As the leading environmental cause of pediatric HL, a cCMV-infected child would be expected to be frequently encountered by audiologists and SLPs. Our study indicated that audiologists and SLPs, like other specialties, require additional knowledge that goes beyond that typically received in their training programs. Greater detail of cCMV characteristics and impact on hearing, speech, language, and vision should be implemented to prepare more completely audiology and speech-language pathology graduates. cCMV education should also be incorporated into ongoing continuing education programs for both the fields of audiology and speech-language pathology. Due to the critical service these providers give to these patients, we recommend improving educational efforts for both groups, as it is vital for providers intimately involved in the care of these children to be well versed with cCMV.

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Appendix (p. 1 of 4)

Awareness Survey

1. Age ____

2. Gender
   a. Female
   b. Male
   c. Prefer not to answer

3. Race
   a. American Indian or Alaska Native
   b. Asian
   c. Black or African American
   d. Native Hawaiian or other Pacific Islander
   e. White
   f. Prefer not to answer

4. Ethnicity
   a. Hispanic or Latino
   b. Not Hispanic or Latino
   c. Prefer not to answer

5. Type of degree:
   a. Audiologists
      i. MA/MS
      ii. AUD
      iii. PHD
      iv. AUD/PHD
      v. AUD/MPH
      vi. Other (specify) ____

   b. Speech and language therapists
      i. MA/MS
      ii. PHD
      iii. Other doctorate (EDH, SCD, CSCD, etc.)
      iv. Other (specify) ____

6. Years in practice
   a. 0–5
   b. 6–10
   c. 11–15
   d. 16–20
   e. > 20

7. Practice environment
   a. Audiology
      i. Private practice associated with an otolaryngology clinic
      ii. Private practice **not** associated with an otolaryngology clinic
      iii. Academic center (e.g., university medical center)
      iv. Children's hospital–based practice
      v. Other hospital–based practice
      vi. Other (specify) _____

b. Speech and language therapists
   i. Early intervention
   ii. School (preschool, K–12, special school, etc.)
   iii. College/university
   iv. Hospital
   v. Home health
   vi. Residential health care facility (skilled nursing facility, etc.)
   vii. Nonresidential health care facility (clinic, physician's office, etc.)
   viii. Industry
   ix. Agency, organization, research facility
   x. Other (specify) _____

8. What % of your practice includes management of pediatric sensorineural hearing loss (SNHL)?
   a. None
   b. 1–25
   c. 26–50
   d. 51–75
   e. > 75

9. How often do you work with children < 5 years old?
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

10. How familiar are you with the following conditions? (Check one response for each row.)

Condition	Not familiar	Slightly familiar	Somewhat familiar	Very familiar
Connexin 26 mutation				
Fetal alcohol syndrome				
HIV				
Kernicterus				
Usher syndrome				
Congenital cytomegalovirus				
Jervell and Lange-Nielsen syndrome				
Down syndrome				
Congenital rubella				
Toxoplasmosis				
Pneumococcal meningitis				
Syphilis				

Appendix (p. 3 of 4)

Awareness Survey

11. What symptoms are associated with congenital cytomegalovirus (cCMV) infection? (Check one response for each row.)

Symptom	Yes	No	I do not know
Hearing loss			
Limb malformation			
Intellectual disability			
Vision loss			
Spina bifida			
Microcephaly			
Motor disabilities			
Vocal cord paralysis			
Seizures			
Death			
Hepatomegaly			
Ventricular septal defect			
Splenomegaly			
Thyroid dysfunction			
Intrauterine growth restriction			
Petechia and purpura			
Patent ductus arteriosus (PDA)			

12. How can hearing loss present in a child with cCMV? (Check one response for each row.)

Presentation	Yes	No	I do not know
Stable			
Progressive			
Fluctuating			

13. Which of the following statement(s) regarding cCMV is/are true? (Check one response for each row.)

Statement	True	False	I do not know
Up to 15% of children with asymptomatic cCMV can develop hearing loss			
Up to 30% of children with asymptomatic cCMV can develop hearing loss			
Up to 75% children with symptomatic cCMV will develop hearing loss			
Up to 95% of children with symptomatic cCMV will develop hearing loss			
cCMV is the most common environmental cause of pediatric hearing loss			

14. Of children with cCMV with hearing loss, what percent will have progressive hearing loss?
    a. 5%
    b. 20%
    c. 35%
    d. 50%
    e. I do not know

15. How often should children with cCMV have hearing evaluation?
    a. Every 3 months
    b. Every 6 months
    c. Every 3 months, increased to monthly if hearing change is identified
    d. Every 6 months, increase to 3 months if hearing loss identified
    e. Yearly, increase to 6 months if hearing loss identified

16. Definitive diagnosis of cCMV is best established by what age?
    a. < 3 weeks
    b. 3–6 weeks
    c. 3 months
    d. 6 months
    e. > 1 year

Appendix (p. 4 of 4)

Awareness Survey

17. Which of the following are routes of transmission for CMV? (Check one response for each row.)

Transmission route	Yes	No	I do not know
Kissing			
Changing diapers			
Cat litter			
Breast milk			
Blood transfusion			
Ingestion of undercooked meat			
Sexual intercourse			
Sharing food with children			
Eating unpasteurized food			
Sneeze/cough			
I do not know			

18. Where did you initially learn about cCMV?
   a. College
   b. Audiology graduate program
   c. On the job as an audiologist
   d. Audiology conference
   e. Otolaryngology conference
   f. OB-GYN visit
   g. Primary care provider visit
   h. Through the Internet
   i. I have never learned about cCMV
   j. Other

19. Do you have any children?
   a. Yes
   b. No

20. Does your institution or hospital offer hearing targeted early cCMV screening?
   a. Yes
   b. No
   c. I do not know

21. Does your institution or hospital offer universal cCMV screening?
   a. Yes
   b. No
   c. I do not know