

# BACTERIAL MENINGITIS AND PEDIATRIC SENSORINEURAL HEARING LOSS IN THE POST-PCV13 ERA.



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## ABSTRACT

**INTRODUCTION:** Bacterial meningitis is the most common cause of postnatally-acquired sensorineural hearing loss (SNHL). Prognostic associations are lacking for pediatric SNHL due to *Streptococcus pneumoniae* bacterial meningitis after the introduction of updated pneumococcal vaccine (PCV13) in 2010. **OBJECTIVES: 1)** To assess clinical presentation of meningitis based on bacterial etiology in children and identify associations with post-meningitic SNHL in children after 2010. **2)** To describe rates of *S. pneumoniae*-associated post-meningitic SNHL based on three time periods: pre-PCV, post-PCV7 and post-PCV13. **METHODS:** A retrospective review was performed for patients 18 years and younger diagnosed with meningitis after January 1, 2010. Patients were identified by history of positive CSF bacterial culture or FilmArray Meningitis/Encephalitis Panel (MEP) assay. Clinical data were stratified by bacterial etiology, analyzed for clinically relevant characteristics, and compared with previously reported rates of post-meningitic SNHL. **RESULTS:** In a cohort of 147 patients with positive CSF cultures, 91 (61.9%) met inclusion criteria. Seventy-one (mean age 21 months, 56% male) had audiograms after diagnosis and were divided into four subgroups based on bacterial etiology: *S. pneumoniae* (n=20), Group B streptococcus (GBS, n=25), *Haemophilus influenzae* (n=10), and Other (n=16). Of those with hearing evaluations, SNHL was reported in 15 patients (21%), most frequently in the *S. pneumoniae* population (n=8/19, 42%). Two (20%) *H. influenzae* patients and two (8%) GBS patient were found to have SNHL. Children in the PCV13 vaccination era had a similar rate of post-meningitic SNHL (42%) as historical pediatric cohorts in the pre-PCV vaccination time period (23.8%), and the PCV7 vaccination time period (35%) (Fisher's exact, p=0.19). **CONCLUSION:** Despite advances in vaccine development for *S. pneumoniae*, SNHL remains a common long-term complication of this disease. Further research into predicting and preventing this outcome is necessary.

## BACKGROUND

• Bacterial meningitis (BM) accounts for 60-90% of all pediatric sensorineural hearing loss (SNHL) cases and is associated with significant morbidity and mortality in children.

• The two most common causes of postnatally acquired SNHL cases are *H. influenzae* type B (HiB) and *S. pneumoniae*.

• Vaccines against HiB and *S. pneumoniae* have dramatically reduced incidence of bacterial meningitis.

• However, the incidence of pediatric SNHL due to pneumococcal meningitis has remained stable at 28-35% between the years of 2007-2013.

• Hearing loss has significant effects on childhood development, contributing to delays in language development and academic performance.

• No prior studies have compared bacterial meningitis and hearing outcomes from children in the pre-PCV, post-PCV7 and post-PCV13 eras.

## OBJECTIVES

• To present a pediatric cohort of patients with bacterial meningitis and SNHL in the post-PCV13 era

• To compare historical data about bacterial meningitis and SNHL from the pre-PCV and post-PCV7 eras with a post-PCV13 pediatric cohort

## METHODS AND MATERIALS

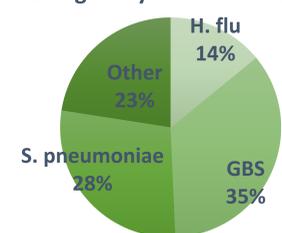
- Institutional review board approval was obtained.
- Chart review of patients with spontaneous bacterial meningitis from 2010-2020
- **Inclusion criteria:** CHCO patients diagnosed with spontaneous bacterial meningitis on or after January 1, 2010. Age 18 years or younger at time of diagnosis. Diagnosis must be made by positive CSF cultures.
- **Exclusion criteria:** Patients with known underlying immunodeficiencies, on biologic agents such as monoclonal antibodies or with bacterial meningitis related to trauma, a shunt infection or a neurological procedure. Patients without culture or PCR-confirmed meningitis due to bacterial etiology.
- Data was compared with previously reported rates of post-meningitic SNHL.

## RESULTS

### Demographics

- 147 patients between 2010-2020
- 91 (61.9%) met inclusion criteria
- Mean age at diagnosis: 23.13 mos
- A total of 71 patients had post-meningitic audiograms available

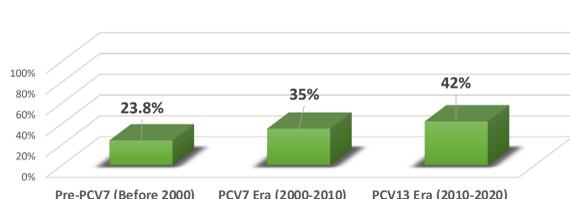
### Meningitis by Bacterial Etiology



### Outcomes

- 19 total patients exhibited post-meningitic hearing loss (HL)
- 2 patients had HL prior to onset of meningitis 5 patients had conductive hearing loss
- 2 patients had mixed HL, both of whom also had SNHL in the other ear
- Pneumococcal meningitis was the most common cause of post-meningitic SNHL with six affected patients (42%)

### SNHL in Post-Pneumococcal Meningitis Patients



	H. flu (N=10)	Other (N=16)	GBS (N=25)	<i>S. pneumoniae</i> (N=20)	Total (N=71)
Age (months)	64.36	18.11	1.15	25.47	20.73
Gender					
Male	6 (60%)	12 (75%)	8 (32%)	14 (70%)	40 (56%)
Female	4 (40%)	4 (25%)	17 (68%)	6 (30%)	31 (44%)
Ethnicity					
Hispanic or Latino	1 (13%)	5 (33%)	5 (21%)	6 (33%)	17 (25%)
Not Hispanic or Latino	7 (88%)	10 (67%)	19 (79%)	13 (67%)	49 (75%)
Race					
White	5 (50%)	11 (69%)	21 (84%)	15 (75%)	52 (74%)
Black/African American	3 (30%)	3 (19%)	0 (0%)	0 (0%)	6 (9%)
Asian	0 (0%)	0 (0%)	1 (4%)	0 (0%)	1 (1%)
More than one race	0 (0%)	1 (6%)	1 (4%)	1 (5%)	3 (3%)
Other	0 (0%)	1 (6%)	2 (8%)	3 (15%)	6 (9%)
Unknown/Not reported	2 (20%)	0 (0%)	0 (0%)	1 (5%)	3 (3%)

Table 1. Demographics and Clinical Characteristics stratified by Bacterial Etiology

Table 2. Outcomes for patients with bacterial meningitis stratified by bacterial etiology

	H. flu (N=10)	Other (N=16)	GBS (N=25)	<i>S. pneumoniae</i> (N=20)	Total (N=71)
Hearing Loss?					
Yes	4 (40%)	4* (27%)	2 (8%)	9* (47%)	19 (28%)
No	6 (60%)	11 (73%)	23 (92%)	10 (53%)	50 (72%)
Deceased?					
Yes	0 (0%)	1 (6%)	0 (0%)	0 (0%)	1 (1%)
No	10 (100%)	15 (94%)	25 (100%)	20 (100%)	70 (99%)

\*1 patient was found to have hearing loss prior to bacterial meningitis diagnosis

## DISCUSSION

- We present a novel analysis of post-meningitic SNHL in a pediatric cohort after the introduction of the PCV13 vaccine in 2010.
- Prior studies from the pre-PCV7 and PCV7-vaccinated eras have reported similar rates of post-meningitic SNHL as our pediatric cohort.
- Our results indicate a need for further exploration of predictive markers in the pathogenesis of post-meningitic SNHL, particularly in pediatric pneumococcal populations.

## CONCLUSION

- Advances in vaccine development have helped reduce incidence of bacterial meningitis in the US due to *H. influenzae* and *S. pneumoniae*.
- Rates of SNHL within post-pneumococcal meningitic populations remain constant in pediatric cohorts since the introduction of PCV7 and PCV13.
- Future directions include univariate testing and potential multivariate analysis if more patients are added that meet inclusion criteria.

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