

12th Annual Otolaryngology Literature Update

Pediatric Otolaryngology III

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Phayvanh P. Pecha, M.D., MPH is an associate professor in the Department of Otolaryngology-Head and Neck Surgery. She stayed on faculty after completing her fellowship in pediatric otolaryngology-head and neck surgery at the Medical University of South Carolina in 2019. She received her medical degree from the University of Minnesota Medical School with honors and completed her residency at the University of Utah.

Dr. Pecha's clinical practice is entirely dedicated to the care of children with ear, nose, and throat disorders. Her specific areas of expertise include treatment of children with ear problems, airway concerns, craniofacial differences, jaw distraction, and cleft lip and palate surgery. She conducts prenatal visits and is a surgeon on the MUSC multidisciplinary Craniofacial and Cleft Team, which is accredited by the American Cleft Palate-Craniofacial Association.

Academically, Dr. Pecha is a health services researcher with a focus on health equity, particularly in the delivery of care for children with obstructive sleep-disordered breathing. She has authored over 45 articles and chapters in medical journals and textbooks. Her research has been presented at regional and national meetings and she has received multiple grants, including the American Academy of Otolaryngology-Head and Neck Foundation as well as a K12 Career Development Grant.

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Banik GL, Empey RM, Lam DJ. Impact of AAO-HNS Guideline on Obtaining Polysomnography Prior to Tonsillectomy for Pediatric Sleep-Disordered Breathing. *Otolaryngol Head Neck Surg.* 2020 Nov;163(5):1038-1043. doi: 10.1177/0194599820926456. Epub 2020 May 19. PMID: 32427548; PMCID: PMC7609601.

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Rollins JT, Wajsberg B, Bitners AC, Burton WB, Hametz PA, Chambers TA, Yang CJ. Admission practices following pediatric tonsillectomy: A survey of ASPO members. *Int J Pediatr Otorhinolaryngol.* 2022 Nov;162:111286. doi: 10.1016/j.ijporl.2022.111286. Epub 2022 Aug 19. PMID: 36206700.

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Pediatric Otolaryngology

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Disclosures

- No disclosures or conflicts of interest.



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Otolaryngol Head Neck Surg. 2020 November ; 163(5): 1038–1043. doi:10.1177/0194599820926456.

Impact of AAO-HNS Guideline on Obtaining Polysomnography Prior to Tonsillectomy for Pediatric Sleep-Disordered Breathing

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Background

- ▶ Over 750,000 adenotonsillectomies (AT) are performed annually in the United States, for which pediatric sleep-disordered breathing (SDB) is the indication in up to 77% of cases.
- ▶ Goal: To assess the impact of the 2011 AAO-HNS guideline on practice patterns in obtaining pre-adenotonsillectomy (AT) PSG for pediatric sleep-disordered breathing (SDB).



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- ▶ Multiple organizations have published guidelines on the use of PSG prior to AT, including the American Academy of Pediatrics (AAP), American Academy of Sleep Medicine (AASM), and AAO-HNS.
 - ▶ The 2002 AAP and 2010 AASM guidelines both recommended PSG to confirm a diagnosis of OSA in any child being considered for AT.
 - ▶ The 2011 AAO-HNS Clinical Practice Guideline recommended pre-AT PSG in a more selective group of children:
 - ▶ considered at high risk for perioperative morbidity (obesity, neuromuscular disorders, Down syndrome, sickle cell anemia, and craniofacial anomalies) or
 - ▶ where there is uncertainty regarding the diagnosis or
 - ▶ severity of SDB due to discordance between reported symptoms and physical examination findings



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Methods

- ▶ This was a retrospective cohort study
 - ▶ multi-provider pediatric otolaryngology clinic at a single tertiary children's hospital
- ▶ The study population included all patients referred to our pediatric otolaryngology clinic for consideration of AT for SDB during two 12-month time periods: before (2010–2011) and after (2015–2016) publication of the 2011 AAO-HNS guideline.
- ▶ Demographic, insurance, comorbidity, and Pediatric Sleep Questionnaire (PSQ) variables were assessed for association with pre-AT PSG using bivariate and multivariate logistic regression analysis.



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Results

- ▶ 1,669 patients met study criteria. Of these, 475 patients were seen for consideration of AT for SDB in 2010–2011 vs. 1,194 patients in 2015–2016.
- ▶ The overall mean age of the study population was 6.8 ± 3.8 years
- ▶ A greater percentage of patients underwent pre-AT PSG in 2015–2016 vs. 2010–2011 (30% vs. 22%, $p=0.001$).
- ▶ Positive PSQ screen was significantly associated with decreased odds of pre-AT PSG in both time periods.



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Presence of neuromuscular disorder was the *only* predictor associated with pre-AT PSG in 2010–2011 (OR 3.00, 95% CI [1.10, 8.06], $p=0.03$).

Presence of **neuromuscular disorder** (OR 2.54, 95% CI [1.51, 4.29], $p<0.0001$), **craniofacial anomaly** (OR 2.32, 95% CI [1.20, 4.50], $p=0.013$), or **Down syndrome** (OR 3.45, 95% CI [1.54, 7.72], $p=0.003$) was associated with pre-AT PSG in 2015–2016.

Frequency of Ordering PSG

PSG Ordered	Overall N = 1,669	Year 2010–2011 N = 475	Year 2015–2016 N = 1,194	p-value
Prior to clinic presentation	260 (16)	80 (17)	180 (15)	0.37
Prior to AT surgery	457 (27)	103 (22)	354 (30)	0.001
Comorbidities				
Neuromuscular disorder	73 (49)	15 (38)	58 (53)	0.13
Craniofacial anomaly	44 (49)	5 (38)	39 (51)	0.42
Down syndrome	49 (56)	10 (56)	39 (57)	0.94
Asthma	62 (32)	10 (17)	52 (39)	0.004
Congenital heart disease	53 (52)	15 (50)	38 (53)	0.80



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Discussion and Conclusion

- ▶ After publication of the 2011 AAO-HNS guideline, there was a significant but modest increase in pre-AT PSG utilization in children with SDB and high-risk comorbidities at this institution
 - ▶ presence of neuromuscular disorder, craniofacial anomaly, or Down syndrome were all significantly associated with pre-AT PSG.
- ▶ Overall adherence remains low as evidenced by 51–57% rates of ordering PSG in patients with high-risk comorbidities after guideline publication
- ▶ As with other institutions across the country, a likely significant contributor to low rates of PSG ordering is limited sleep lab capacity with long wait times of up to several months for PSG.



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Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl



Admission practices following pediatric tonsillectomy: A survey of ASPO members

Jay T. Rollins^a, Benjamin Wajsberg^a, Anna C. Bitners^b, William B. Burton^a,
Patricia A. Hametz^{a,c}, Terry-Ann Chambers^{a,d}, Christina J. Yang^{a,c,e,*}

- Although evidence-based Clinical Practice Guidelines have specified postoperative admission criteria for pediatric tonsillectomy, there is substantial variation in guideline implementation and adherence among otolaryngologists in practice.
- Several factors could influence implementation:
 - consideration of the risks and drawbacks of hospitalization
 - skepticism regarding age as a primary criterion for hospital admission
 - costs associated with admission in strict adherence with the guidelines
 - desire to incorporate wider variability of patient and provider factors.



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Background

- ▶ T&A is one of the most common procedures in children <15 years
 - ▶ most common indication is for treatment of OSA
- ▶ Updated AAO-HNS guidelines placed greater weight on hypoxia (O2 saturation <80%) observed on preoperative PSG
 - ▶ citing evidence that, while AHI remained a significant predictor, O2 saturation was the single strongest predictor of postoperative complications
- ▶ Assess pediatric otolaryngologists' post-tonsillectomy admission practices and to examine patient and surgeon factors associated with differences in admission practices.



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Methods

- ▶ An electronic cross-sectional survey was distributed to members of the American Society of Pediatric Otolaryngology (ASPO) to determine current practices regarding admission practices following pediatric tonsillectomy.
 - ▶ 20 questions with open-ended questions
 - ▶ July 2021
- ▶ Chi-square and Fischer's exact tests



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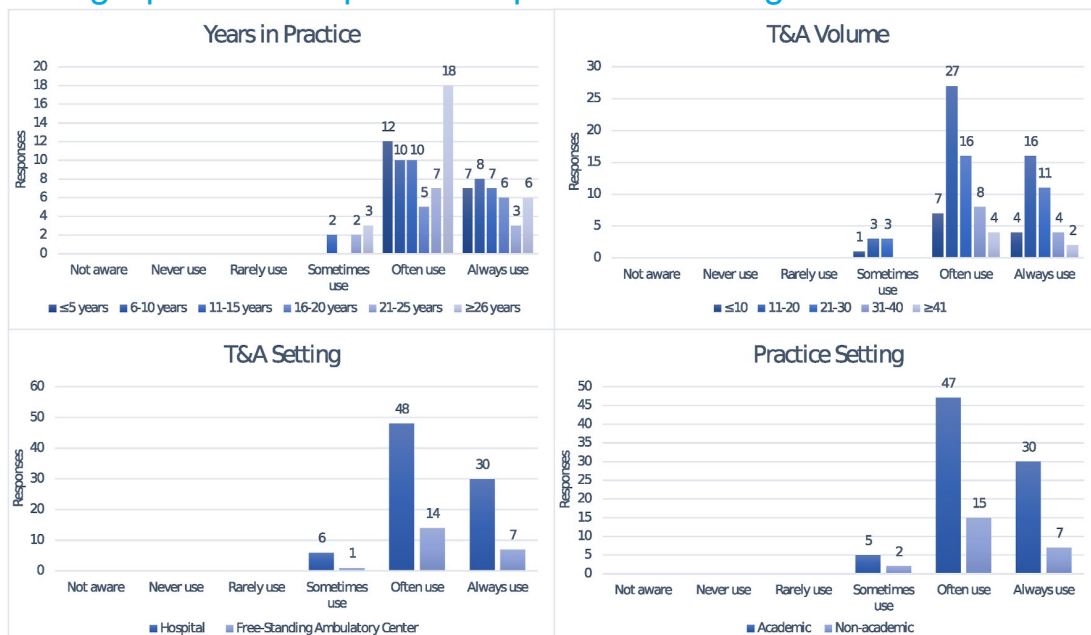
Results

- ▶ The survey was sent to 644 pediatric otolaryngologists
 - ▶ Completed by 123 respondents, response rate 19.1%
 - ▶ 77.6% of respondents were in academic practice
 - ▶ 81.0% perform surgery in a hospital setting and 19% in an ambulatory surgery center
- ▶ 37% of respondents reported “always” and 60% “often” using the AAO-HNS CPG to guide decision for admission
- ▶ 13.8% used less strict age criteria in their practice



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Demographics of respondents per AAO-HNS guideline adherence



Results

- ▶ Years in practice was the factor most strongly associated with admission practices
 - ▶ 10 or fewer years in practice significantly correlated with stricter adherence to the AAO-HNS CPG of overnight observation when AHI ≥ 10 , age < 3 years, or O2 nadir $< 80\%$ (OR 4.2, $p < 0.001$)
- ▶ Respondents in an academic practice setting were more likely to admit children < 3 years of age than those in private practice (OR 5.0, $p = 0.01$).
- ▶ No differences were seen for T&A volume, T&A setting, or practice setting.



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Discussion

- ▶ Overall, there was a large consensus among respondents regarding AHI criteria for overnight admission, indicating awareness and acceptance of the 2019 AAO-HNS CPG.
- ▶ However, some respondents reported familiarity with the AAP criteria instead, which uses a higher threshold for AHI and could explain the range of responses regarding that criterion.
 - ▶ Indeed, the expert panel which created the CPG noted a lack of consensus regarding the AHI cutoff (10 vs. a higher AHI) in the literature
- ▶ Among respondents, there was less agreement regarding O2 nadir thresholds for admission.
 - ▶ Could reflect less adherence to CPGs, less consensus regarding where the cutoff should be, or heavier reliance on other variables to make decisions regarding overnight admission.
- ▶ Age criteria demonstrated the highest consensus, with 80% of respondents indicating that they would admit children under the age of 3 for overnight observation.



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Conclusion

- ▶ Limitations: low response rate and selection bias in electronic survey and targeting ASPO members.
- ▶ Admission practices varied among pediatric otolaryngologist survey respondents, and strict AAO-HNS CPG adherence was associated with fewer years in practice and academic practice setting.
- ▶ Surgery setting and surgeon volume were not associated with CPG adherence.
- ▶ These results suggest that further study investigating factors influencing guideline adherence and post-tonsillectomy admission practices is warranted.



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Guidelines Executive Summary

Executive Summary of Clinical Practice Guideline on Tympanostomy Tubes in Children (Update)



Otolaryngology–
Head and Neck Surgery
2022, Vol. 166(2) 189–206
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DOI: 10.1177/01945998211065661
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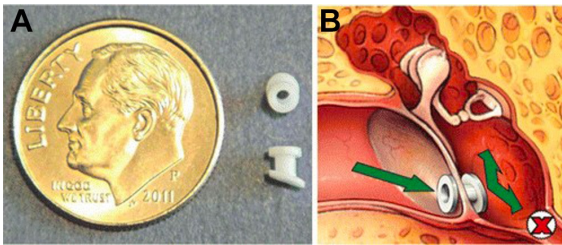
- ▶ Applies to children 6 months to 12 years with tympanostomy tubes (TT) or children being considered for TT as an intervention for otitis media of any type.
- ▶ An update was necessitated by an >5-year lapse and by subsequent original research and systematic reviews that might modify existing recommendations or support new ones.
 - ▶ New evidence from 6 clinical practice guidelines, 18 systematic reviews, and 27 RCTs
- ▶ Emphasis on patient education and shared decision making with new tables of counseling opportunities and frequently asked questions



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STRONG RECOMMENDATIONS- key action statements:

- ▶ Clinicians should prescribe topical antibiotic ear drops only, without oral antibiotics, for children with uncomplicated acute tympanostomy tube otorrhea.
- ▶ The surgeon or designee should examine the ears of a child within 3 months of TT insertion AND should educate families regarding the need for routine, periodic follow-up to examine the ears until the tubes extrude.



RECOMMENDATIONS - key action statements:

- ▶ Clinicians should **not** perform TT insertion in children with a single episode of OME of less than 3 months' duration, from the date of onset (if known) or from the date of diagnosis (if onset is unknown).
- ▶ Clinicians should obtain a hearing evaluation if OME persists for 3 months or longer OR prior to surgery when a child becomes a candidate for TT insertion.
- ▶ Clinicians should offer bilateral TT insertion to children with bilateral OME for 3 months or longer AND documented hearing difficulties.

RECOMMENDATIONS - key action statements:

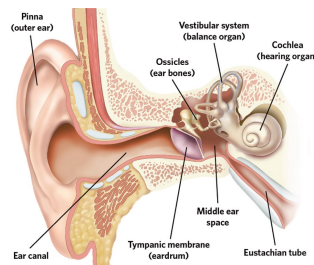
- ▶ Clinicians should reevaluate, at 3- to 6-month intervals, children with chronic OME who do not receive TT, until the effusion is no longer present, significant hearing loss is detected, or structural abnormalities of the tympanic membrane or middle ear are suspected.
- ▶ Clinicians should **not** perform TT insertion in children with recurrent AOM who do not have middle ear effusion in either ear at the time of assessment for tube candidacy.
- ▶ Clinicians should offer bilateral TT insertion in children with recurrent AOM who have unilateral or bilateral MEE at the time of assessment for tube candidacy.



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RECOMMENDATIONS - key action statements:

- ▶ Clinicians should determine if a child with recurrent AOM or with OME of any duration is at increased risk for speech, language, or learning problems from otitis media because of baseline sensory, physical, cognitive, or behavioral factors.
- ▶ The clinician should **not** place long-term tubes as initial surgery for children who meet criteria for tube insertion unless there is a specific reason based on an anticipated need for prolonged middle ear ventilation beyond that of a short-term tube.



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RECOMMENDATIONS - key action statements:

- ▶ In the perioperative period, clinicians should educate caregivers of children with TT regarding the expected duration of tube function, recommended follow-up schedule, and detection of complications.
- ▶ Clinicians should **not** routinely prescribe postoperative antibiotic ear drops after TT placement.
- ▶ Clinicians should **not** encourage routine, prophylactic water precautions for children with tubes.



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OPTIONS - key action statements:

- ▶ Clinicians may perform TT insertion in children with unilateral or bilateral OME for 3 months or longer (chronic OME) AND symptoms that are likely attributable, all or in part, to OME that include, but are not limited to, balance (vestibular) problems, poor school performance, behavioral problems, ear discomfort, or reduced quality of life.
- ▶ Clinicians may perform TT insertion in at-risk children with unilateral or bilateral OME that is likely to persist as reflected by a type B tympanogram or a documented effusion for 3 months or longer.
- ▶ Clinicians may perform adenoidectomy as an adjunct to TT insertion for children with symptoms directly related to the adenoids (adenoid infection or nasal obstruction) OR in children aged **4 years or older** to potentially reduce future incidence of recurrent otitis media or the need for repeat tube insertion.



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Changes in content from 2013 guideline:

- ▶ A new **strong recommendation** that the surgeon, or designee, should examine the ears of a child within 3 months after TT insertion to assess outcomes and should educate families regarding the need for routine, periodic follow-up to examine the ears until the tubes extrude
- ▶ A new **option** for the clinician to perform adenoidectomy as an adjunct to TT insertion for children with symptoms directly related to the adenoid (adenoid infection or nasal obstruction) or in children aged 4 years or older to reduce future incidence of recurrent otitis media or the need for repeat tube insertion



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Changes in content from 2013 guideline:

- ▶ A new recommendation **against**:
 - ▶ placing long-term tubes as initial surgery for children who meet criteria for tube insertion unless there is an anticipated need for prolonged middle ear ventilation beyond that of a short-term tube
 - ▶ routinely prescribing prophylactic antibiotic ear drops after tympanostomy tube surgery to prevent or reduce otorrhea



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Table 2. Risk Factors for Developmental Difficulties.^a

Permanent hearing loss independent of otitis media with effusion (OME)
 Suspected or confirmed speech and language delay or disorder
 Autism spectrum disorder
 Syndromes (eg, Down) or craniofacial disorders that include cognitive, speech, or language delays
 Blindness or uncorrectable visual impairment
 Cleft palate, with or without associated syndrome
 Developmental delay
 Intellectual disability, learning disorder, or attention-deficit/hyperactivity disorder^b

^aSensory, physical, cognitive, or behavioral factors that place children who have OME at increased risk for developmental difficulties (delay or disorder).²²

^bThe conditions in this row are a new addition to the list.

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Changes in content from 2013 guideline:

- ▶ Addition of **intellectual disability, learning disorder, or ADHD** to the list of risk factors that place children who have otitis media with effusion (OME) at increased risk for developmental difficulties (at-risk child)
- ▶ Updated categories of normal to mild hearing loss in children:
 - ▶ normal hearing as 0 to 15 decibels (dB)
 - ▶ slight hearing loss as 16 to 25 dB
 - ▶ mild hearing loss as 26 to 40 dB

Genetics in Medicine (2022) 24, 1392–1406


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ACMG PRACTICE RESOURCE

Clinical evaluation and etiologic diagnosis of hearing loss: A clinical practice resource of the American College of Medical Genetics and Genomics (ACMG)



Marilyn M. Li¹, Ahmad Abou Tayoun², Marina DiStefano³, Arti Pandya⁴, Heidi L. Rehm⁵, Nathaniel H. Robin⁶, Amanda M. Schaefer⁷, Christine Yoshinaga-Itano⁸; on behalf of the ACMG Professional Practice and Guidelines Committee^{9,*}



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Background

- ▶ 2-3 every 1000 children born in the US are deaf or have HL significant enough to affect speech and language development.
- ▶ 95% of newborns with HL identified by NBHS programs are born to hearing parents, obscuring the fact that most newborns have a hereditary cause for their HL
- ▶ 60% of educationally significant congenital and early-onset HL is caused by genetic factors
- ▶ Most genetic HL is inherited in an autosomal recessive pattern and often presents in the absence of a positive family history for HL (GJB2)
- ▶ Obtaining an etiologic diagnosis also provides the basis for precise genetic counseling that includes an accurate estimation of the chances for recurrence of HL within families.



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Background – congenital hearing loss

- ▶ An estimated 30% of genetic HL is syndromic.
 - ▶ A few syndromes, such as Pendred (enlarged vestibular aqueduct, thyroid problems), Usher (retinitis pigmentosa), Waardenburg (pigmentary anomalies), and branchiootorenal (branchial arch and renal anomalies) syndromes, account for substantial percentages of HL in some populations.
- ▶ An estimated 70% of genetic HL is nonsyndromic.
 - ▶ Nonsyndromic HL may be transmitted as:
 - ▶ autosomal recessive (~80%)
 - ▶ autosomal dominant (~15%), or
 - ▶ X-linked trait (~1%)



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Background – unilateral hearing loss

- ▶ Unilateral HL can present a diagnostic challenge because it may progress to bilateral HL, represent a nongenetic condition (cCMV), or be caused by a condition that involves an inner ear malformation or cochlear nerve anomaly.
- ▶ The diagnostic yield of NGS HL gene panel testing for unilateral HL is around 1% to 5%, with most diagnoses caused by syndromic etiologies.
- ▶ Genetic testing for unilateral HL should be considered to investigate possible genetic etiologies, particularly because syndromes can present with subtle findings.
 - ▶ If nongenetic causes are ruled out, or if a genetic cause cannot be ruled out, NGS gene panel testing for HL is warranted.



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- ▶ Certain environmental (nongenetic) factors play a major etiologic role in HL.
- ▶ cCMV infection is the most common nongenetic cause of HL among children.
 - ▶ Of the 20,000 to 40,000 infants born with cCMV infection each year, 90% have no detectable clinical abnormalities at birth, yet 10% to 15% of these asymptomatic infants will develop sensorineural HL, which can present in early childhood, can be unilateral or bilateral, and is often progressive.
- ▶ As a result, cCMV infection may go undetected even in children who undergo NBHS and receive a thorough physical examination in the neonatal period



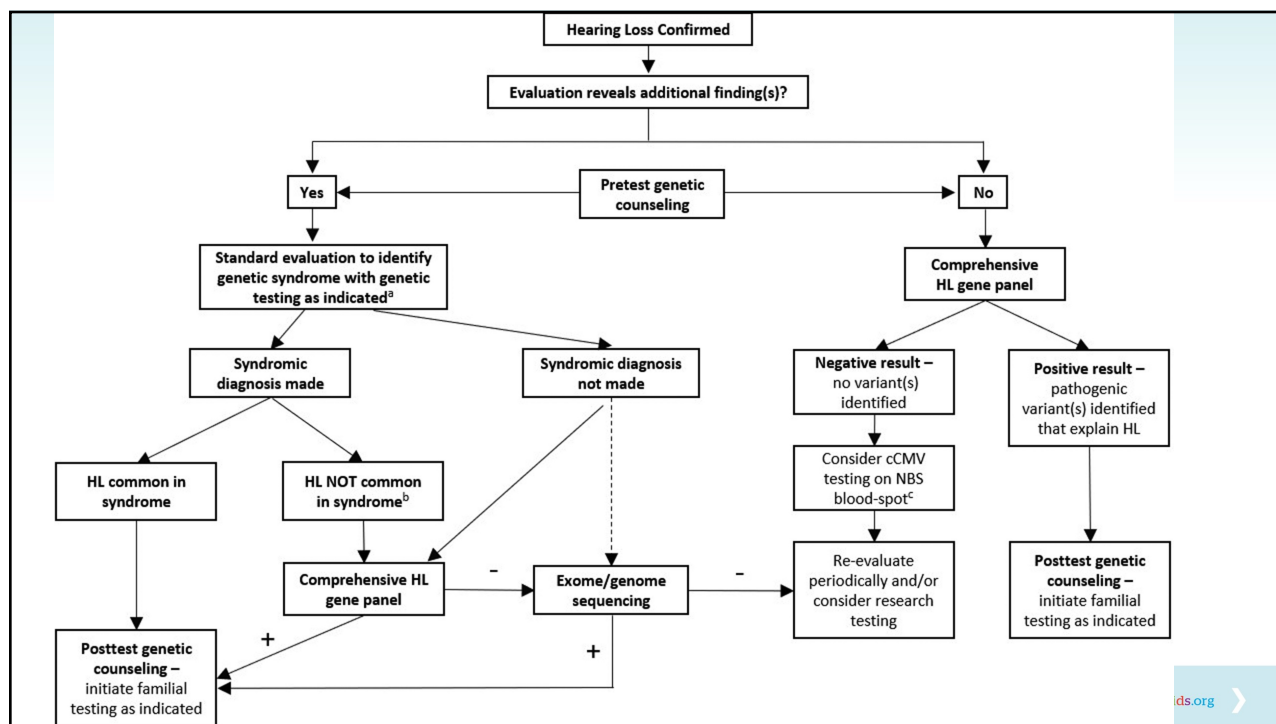
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Genetic Evaluation and Genetic Counseling

- ▶ Because genetic etiology is likely in most infants and children with HL, clinical genetics evaluation, including genetic counseling, should be offered to every child with confirmed HL. Benefits can include:
 - ▶ providing etiologic information
 - ▶ identifying comorbidities that may need referral for specialty care
 - ▶ planning for future medical and educational needs
 - ▶ facilitating estimations of the likelihood of recurrence
 - ▶ allowing families to better plan for the birth of a deaf or hard-of-hearing child
 - ▶ relieving the guilt that some parents may feel about having a child with HL
 - ▶ enhancing psychological well-being, dispelling misinformation, and facilitating identification and referral for unrelated hereditary conditions such as familial cancer



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Recommendation 1:

- ▶ All newborns and infants with confirmed HL should undergo a comprehensive evaluation in which patient-focused medical and birth histories, a 3-generation pedigree, and family medical history are obtained, and a physical examination that focuses on dysmorphic physical findings is performed.
- ▶ Evaluation of children and young adults with HL should follow a similar approach.
- ▶ Evaluation of deaf or hard-of-hearing adults should be customized based on the age of onset and other characteristics of HL

Recommendation 2:

- ▶ For individuals with findings that suggest a syndromic genetic etiology for their HL:
 - ▶ Pretest genetic counseling should be provided, and, with patient's or caregiver's informed consent, genetic testing should be ordered to confirm the diagnosis.
 - ▶ testing may include single-gene tests, HL multigene panels, ES, GS, chromosome analysis, or microarray- or NGS-based copy number analysis
 - ▶ Appropriate studies should be undertaken to determine whether other organs are involved; and
 - ▶ Appropriate near-term and long-term screening and management should be arranged, including referrals to specialists, as indicated by the associated manifestations of the particular syndrome.



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Recommendation 3:

- ▶ For individuals lacking physical findings suggestive of a known syndrome, a tiered diagnostic approach should be implemented.
 - ▶ Unless clinical and/or family history suggests a specific genetic etiology, comprehensive HL gene panel testing should be initiated. If panel testing is negative, genome-wide testing, may be considered.
- ▶ Temporal bone CT or MRI should be considered as a complement to genetic testing, particularly if the diagnosis remains unclear; if cochlear implantation is being considered; if auditory neuropathy is noted, in cases of progressive HL; or if other clinical concerns exist.
 - ▶ The anticipated clinical utility of imaging studies should be balanced against the risks associated with radiation exposure and sedation.
- ▶ CMV testing should be done as soon as possible after birth but within the first 3 weeks of life for infants with congenital HL.
 - ▶ For later-onset or progressive HL, CMV testing can be obtained, but the likelihood that a positive test is caused by postnatal exposure increases with age.



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Recommendations 4 and 5:

- Referral to a multidisciplinary care center, when available
 - A team approach that includes otolaryngologists, clinical geneticists, genetic counselors, audiologists, SLP, early hearing intervention and family support specialists
- For cases in which the genetic evaluation failed to identify an underlying cause, periodic follow-up care every 3 years with a geneticist may be appropriate.
 - subtle features of syndromic forms of HL may not be apparent at birth or early in childhood
 - follow-up visits offer the opportunity to inform individuals about new genetic tests that may have become available or changes in the interpretation of previous test results as medical knowledge advances.
- Regardless of whether genetic test results are positive, negative, or inconclusive, results should be communicated through the process of genetic counseling and potential risks to other family members should be conveyed.



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Conclusion

- ▶ Early detection of HL in newborns is critical for intervention and promoting language development.
- ▶ Although the current NBHS has significantly improved outcomes of newborns with HL, it may miss mild congenital HL, later-onset childhood HL, risk factors for aminoglycoside-induced HL, and auditory neuropathy, resulting in potentially preventable adverse outcomes.
- ▶ Currently, the cost of sequencing and complexity of result interpretation are the major hurdles for universal genetic screening.
 - ▶ As sequencing costs decrease and knowledge regarding the genes and variants improves, genetic screening is likely to become part of more comprehensive universal newborn screening.



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JAMA Otolaryngology–Head & Neck Surgery | Review

Airway Complications Resulting From Pediatric Esophageal Button Battery Impaction A Systematic Review

Justine Philteos, MD; Adrian L. James, MA, DM; Evan J. Propst, MD, MSc; Olivia Ostrow, MD;
Nicole McKinnon, MD, PhD; Tobias Everett, MBChB, MSc, EDRA; Nikolaus E. Wolter, MD, MSc



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Background



- ▶ **Button batteries (BBs) are commonly found in many household items and present a risk of severe injury to children if ingested.**
 - ▶ direct apposition of the trachea and recurrent laryngeal nerves with the esophagus puts children at risk of airway injury 2/2 the liquefactive necrotic effects of BB impactions.
- ▶ **Clear increase in morbidity and mortality because of BB ingestion in past 2 decades**
 - ▶ >90% of serious outcomes from BB ingestion in children were due to larger (≥ 20 mm in diameter), more powerful lithium batteries
 - ▶ children younger than 5 years are at greater risk
 - ▶ rapid accumulation of hydroxide free radicals causes penetrating liquefactive necrosis in as little as 2 hours
- ▶ **Goals: review airway injuries of BB ingestion in children**



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Methods

- ▶ Comprehensive search of MEDLINE, Embase, Cochrane Database of Systematic Reviews, Web of Science, and CINAHL (Cumulative Index of Nursing and Allied Health Literature) from inception to July 31, 2021, in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline
- ▶ Studies with pediatric patients (<18 years) who developed airway injuries after BB ingestion were included.
- ▶ Nonairway injuries were excluded, as were studies not written in English.



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Results

Figure 1. PRISMA Flowchart

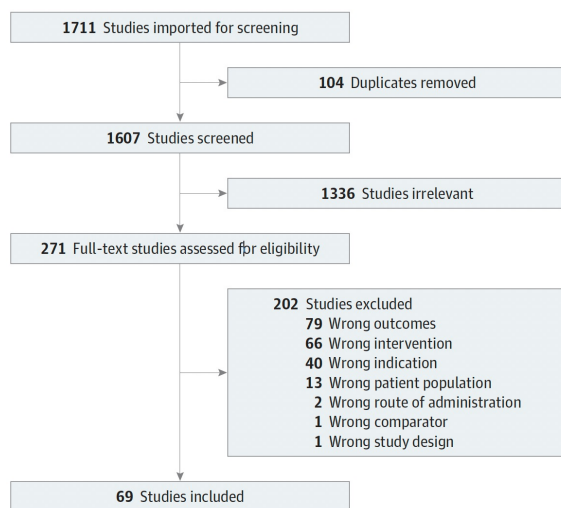


Table 1. Demographic Characteristics of Children

Characteristic	Age, mean (SD), mo	Time from BB ingestion to removal, mean (SD), h
All included children	17.8 (10.2)	138.7 (216.7)
Children with esophageal fistula	17.4 (10.3)	141.8 (194.9)
Children with vocal cord paralysis	19.7 (11.8)	17.8 (22.5)
Children with other airway injuries	13.7 (5.6)	23.1 (30.7)
Children with multiple airway injuries	13.2 (6.0)	26.9 (34.3)
Children who died	11.8 (11.0)	66.9 (77.1)



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Results

- ▶ The timeline between BB removal and diagnosis of airway injury was identified for 85 cases.
 - ▶ 42% were identified at BB retrieval, and 49 cases (58%) had a delayed presentation of airway injury.
 - ▶ The mean (SD) age was 28.9 (10.4) months.
 - ▶ The mean time (SD) since BB ingestion in this subgroup was 170 (253.1) hours.
 - ▶ Most were TEFs (29 of 39 [74%]), followed by BVCP (5 of 39 [13%]).
 - ▶ Most children with these injuries initially presented with cough (n = 28), dysphagia (n = 11), and fever (n = 10).



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Results - Tracheoesophageal fistula

- ▶ TEF occurred in 155 of 195 children (79%).
 - ▶ Thirteen children (7%) had a concurrent second airway injury, including 5 UVCPs, 4 BVCPs, 1 subglottic stenosis, 1 tracheal stenosis, and 2 tracheomalacia.
- ▶ The mean (SD) duration of BB impaction leading to TEF was 5.9 days (8.2 days) and 51 of 89 TEFs (57%) were located in the proximal esophagus.
- ▶ 9% of 155 patients with TEF received a tracheostomy, 6 underwent successful decannulation.
- ▶ Most TEFs were managed with surgical intervention (99 of 125 [79%]).
 - ▶ children requiring repair were older than those who spontaneously recovered (18.8 vs 2.2 mo)
 - ▶ 15 children received ECMO perioperatively
- ▶ Presenting symptoms were not predictive of spontaneous closure (12 days to 7 weeks).
 - ▶ 10 patients received nutritional supplementation via nasogastric or nasojejunal feedings, 5 via gastrostomy tube, and 3 via total parenteral nutrition.



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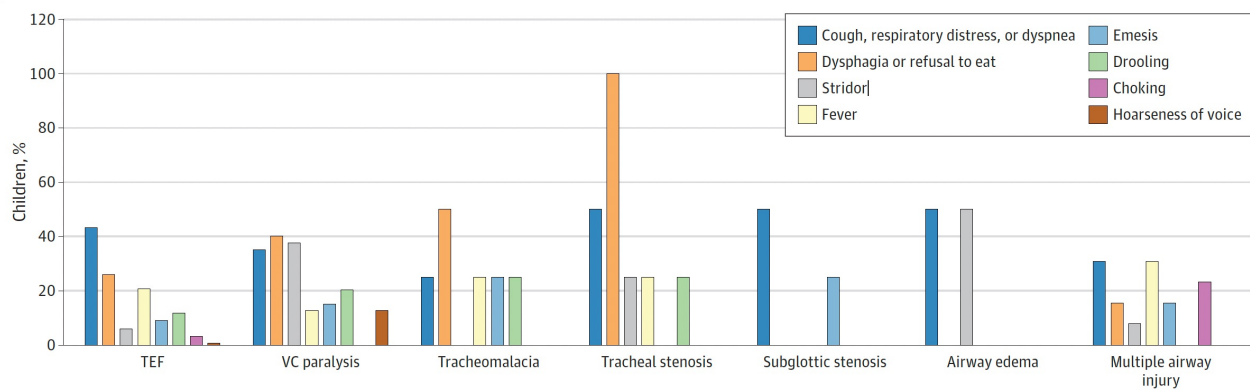
Results – Vocal fold paralysis

- ▶ The mean age of children with vocal cord paralysis was 19.7 (11.8) months.
 - ▶ 12% had BVCP, and 8% had UVCP.
 - ▶ All BBs with documented size and chemistry were lithium BBs (min diameter of 20 mm).
- ▶ The mean duration from ingestion to removal was 17.8 (22.5) hours (range, 3 to 96 hours)
- ▶ The mean duration of ingestion leading to vocal cord paralysis was significantly shorter than that of the general cohort (138.7 vs 17.8 hours).
- ▶ 83% BB ingestions leading to vocal cord paralysis were in the proximal esophagus
- ▶ 41% of 39 children with vocal cord paralysis underwent tracheostomy, 5 (31%) of whom also underwent decannulation.
 - ▶ Six of the 16 children (38%) recovered vocal cord function. The duration from injury to return of vocal cord movement ranged from 2 to 15 months.



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Figure 3. Presenting Symptoms and Etiology Compared by Final Airway Injury Diagnosis



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Discussion

- ▶ Most BB impactions causing airway injury were in the proximal esophagus
 - ▶ Button batteries located in the proximal esophagus with the negative pole facing anteriorly are believed to be more likely to cause vascular injuries, TEF, and vocal cord paralysis
- ▶ Anteroposterior and lateral radiographs of chest and airway to help differentiate the coin ingestion from BB ingestions.
 - ▶ Careful examination of these radiographs for the halo sign, as well as the step-off between the positive and negative nodes of BBs, should be performed.
 - ▶ Furthermore, the radiograph may help to determine the size of the battery and its location for surgical planning and risk stratification.



Discussion and Conclusions

- ▶ TEF was the most common injury, with most patients requiring surgical management.
 - ▶ Spontaneous closure of TEFs was found to occur in younger children
- ▶ After BB removal, bronchoscopy should be performed to examine the trachea in the area of injury to rule out TEF and establish a baseline for future assessment.
 - ▶ Because airway injuries such as TEF can present late, otolaryngologists should be part of the follow up
- ▶ 39% of children had vocal cord paralysis after BB ingestion and had a significantly shorter duration of BB impaction
 - ▶ suggests that serious airway injury can occur in the absence of perforation even after short periods of BB exposure
- ▶ Use of a level I trauma activation significantly reduced the time to evaluation and removal of BBs, from 183 minutes to 33 minutes, compared with that for a standard emergency triage group.

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Thank you



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