Accuracy of Otitis Media Diagnosis According to Instrumentation and Training

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Introduction

- **Otitis media** (OM) affects more than **80%** of pediatric patients at least once [1] and costs the US **over $1 billion annually** (i.e. ambulatory visits and meds).[2]
- Even with established guidelines for OM treatment, the diagnosis continues to be provider dependent.
- Pneumatic otoscopes, tympanometers, and binocular microscopes augment the features of traditional otoscopes, promoting greater diagnostic accuracy.
- The following systematic review and meta-analysis investigates the pooled sensitivity and specificity of pneumatic otoscopy, tympanometry, and binocular microscopy to determine accuracy and factors that affect OM diagnoses.

Figure 1: Healthy tympanic Membrane. Source: MEDtube

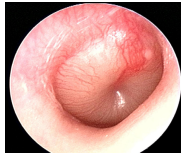

Figure 2: Bulging TM in acute otitis media. Source: UW-Pediatrics

Methods

Studies were retrieved from from PubMed, EMBASE, and Cochrane, following a search for the terms "otitis media," "diagnosis," "otoscopes," and "diagnostic imaging". Studies published between 1976 and 2022 that examined the sensitivity, specificity, or accuracy of pneumatic otoscopes, tympanometers, or binocular microscopes, for diagnosing OM, were initially selected and excluded based on criteria listed in Figure 1, following review by at least two of the authors. Analysis employed R Statistical software to generate pooled sensitivity and specificity, student's t-test, I^2 statistics, and subgroup variable analyses.

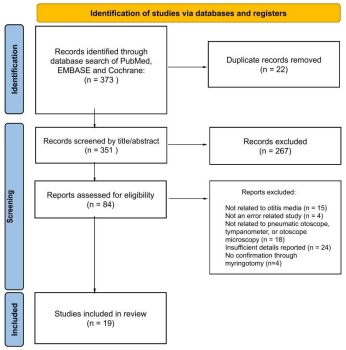

Figure 3: Prisma diagram of selected articles.

Results

1a.

Instrument	Sensitivity (%)	CI (95%)	I2 (%)	Specificity (%)	CI (95%)	I2 (%)
Pneumatic Otoscope	92.30	85.27 - 96.07	97.00	76.46	65.65 - 84.67	97.60
Tympanometer	88.32	85.15 - 90.88	85.50	66.98	52.47 - 78.84	92.80
Binocular Microscope	93.76	80.03 - 98.25	46.40	84.91	73.56 - 91.92	76.00

1b.

Instrument	Sensitivity (p<0.05)	Specificity (p<0.05)
Binocular Microscope vs. Tympanometer	0.41	0.09
Binocular Microscope vs. Pneumatic Otoscope	0.58	0.43
Tympanometer vs. Pneumatic Otoscope	0.84	0.23

1c.

	Pneumatic Otoscope		Tympanometry		Binocular Microscopy	
Variable	Sensitivity (p<0.05)	Specificity (p<0.05)	Sensitivity (p<0.05)	Specificity (p<0.05)	Sensitivity (p<0.05)	Specificity (p<0.05)
Age	0.69	0.80	0.17	0.74	0.14	0.015
Year of Publication	0.72	0.69	0.64	0.25	*	*
Number of Ears Evaluated	0.19	0.56	0.93	<0.0001	‡	‡
Specialization/ Training	<0.0001	0.26	0.88	0.0005	§	§

Table 1a: Comparison of sensitivity and specificity of instrumentation, from 19 selected studies with a 95% confidence interval. N = 20,989 ears. I^2 values greater than or equal to 75% denoted high heterogeneity. **Table 1b:** Comparison of sensitivity and specificity of instrumentation with p<0.05 used to determine significance. **Table 1c:** Subgroup analysis of meta-regression variables for inter-study heterogeneity. Studies categorized by age (<4 yrs, >4 yrs), publication date (pre/post 2000), ears analyzed (<500, 501-1000, >1001), and training (ENT, pediatricians, audiologists, other). ** No papers before 2000. ‡ No papers < 500 ears. § No papers where analysis was done by multiple specialities/training*

Results

- Binocular microscopy showed the highest sensitivity and specificity, followed by pneumatic otoscopy, and finally tympanometry.
- No significant difference in sensitivity or specificity between instruments.
- Pneumatic otoscopy and tympanometry studies showed high heterogeneity, while binocular microscopy studies showed low heterogeneity.
- Individual predictors of sensitivity or specificity based on the subgroup:
  - Pneumatic otoscopy: provider training was a significant predictor of sensitivity.
  - Tympanometry: study size & training were significant predictors of specificity.
  - Binocular microscopy: participant age was a significant predictor of specificity.

Discussion and Conclusion

- Among the tools surveyed, there was no difference in sensitivity or specificity in OM diagnosis.
- Provider specialty and experience played a significant role in instrument sensitivity and specificity.
- Increased training on identifying tympanic membrane pathologies has the greatest potential to impact clinical management.
- One major limitation was the high inter-study heterogeneity and the limited available data. Level of training with the instrument may have also contributed sensitivity and specificity differences.[3,4,5,6]
- New methods for improved diagnostic accuracy are under investigation such as optical coherence tomography, Raman Spectroscopy, and AI-based methods.[7,8,9]

Figure 4: Pneumatic Otoscope[10]

Figure 5: Tympanometer[11]

Figure 6: Binocular Microscopy[12]

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