

# Practical Tympanometry for Providers of Pediatric Health Care



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EHDI Conference  
March 2, 2010

# AAP Clinical Report on Hearing Assessment in Infants and Children



## Key Point #4:

- All providers of pediatric health care should be proficient with pneumatic otoscopy and **tympanometry**. However it is important to remember these methods do not assess hearing.

## Key Point #7:

- Any abnormal objective screening result requires audiology referral and definitive testing.

# Objectives



- ❧ Definition/Function of Tympanometry
- ❧ Diagnostics & Interpretation
  - ❧ Tympanometric parameters
- ❧ Tympanometry: Infant vs. Child vs. Adult
- ❧ Etiologies commonly seen in practice
- ❧ Pros/cons of clinically available equipment

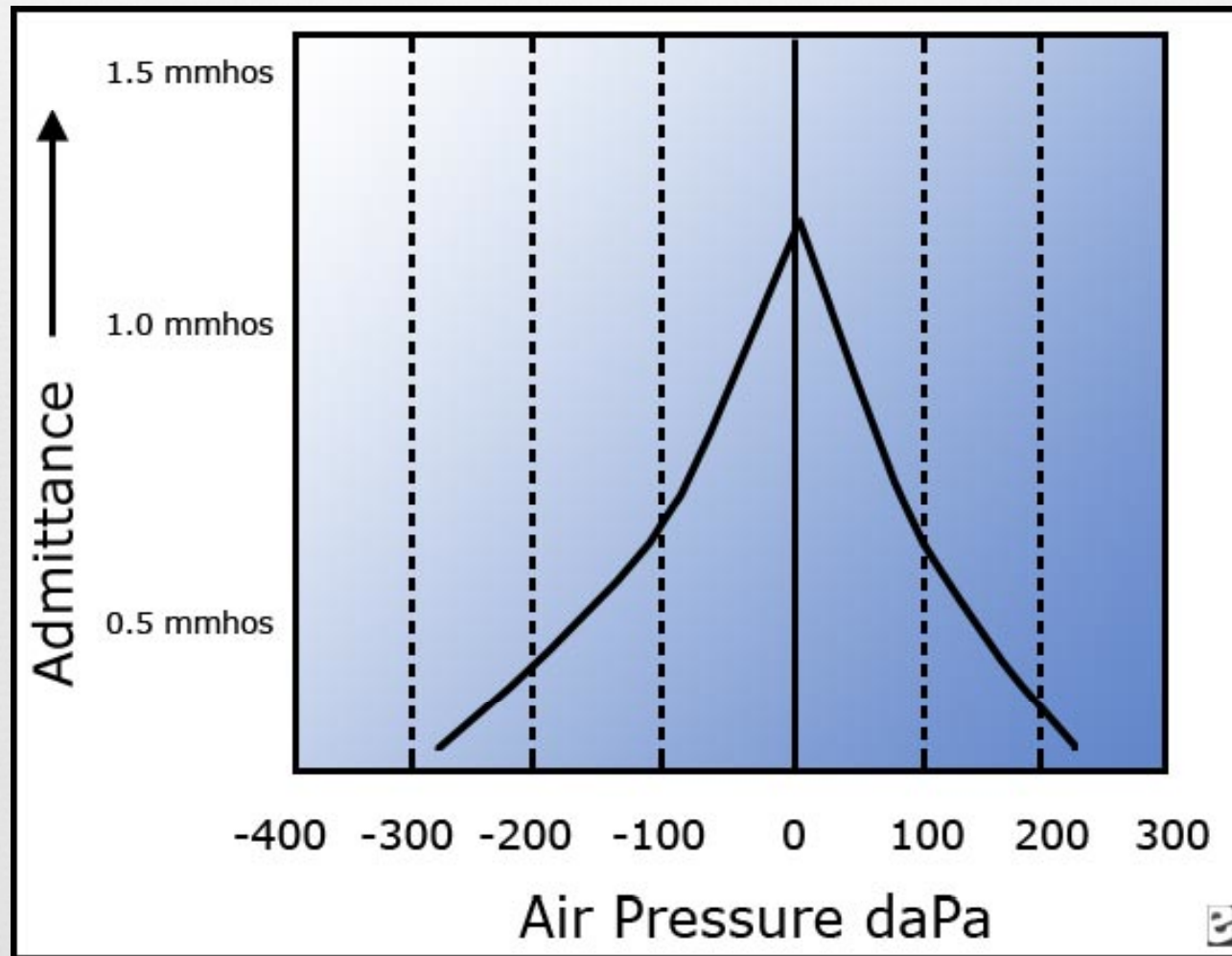


# Basics



- ❧ Tympanometry assesses the overall condition of the outer ear, middle ear, and Eustachian tube
  - ❧ Involves measurement of acoustic immittance in the ear canal as air pressure is varied above and below the atmospheric level
  - ❧ Immittance is a general term that indicates either acoustic impedance or admittance
- ❧ Graphical representation is a tympanogram
  - ❧ Acoustic admittance as a function of ear canal pressure

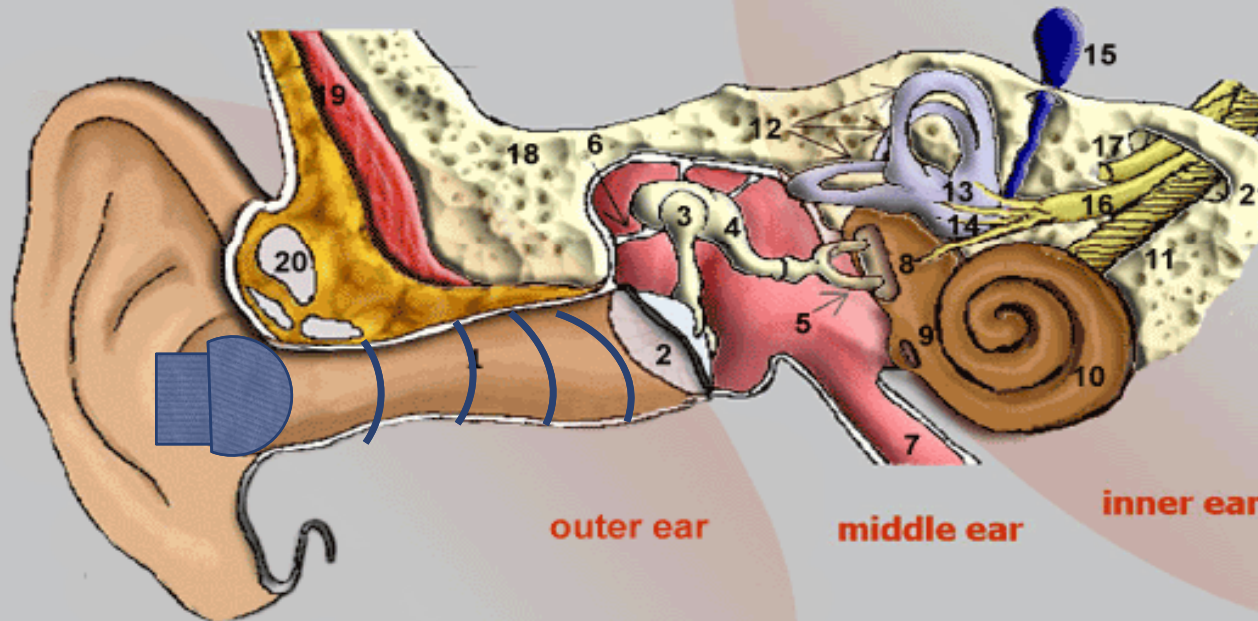
# Tympanogram – 226 Hz



# How it works

## Ear diagram

©Vestibular Disorders Association



1. external auditory canal
2. tympanic membrane (eardrum)
3. malleus
4. incus
5. stapes
6. ligament
7. Eustachian tube

8. oval window
9. round window
10. cochlea
11. cochlear nerve
12. semicircular canals
13. utricle
14. saccule

15. endolymphatic sac
16. vestibular nerve
17. facial nerve
18. temporal bone
19. muscle
20. cartilage
21. internal auditory canal to brain



# Tympanometric Parameters



- ∞ Equivalent Ear Canal Volume (ECV)
- ∞ Tympanometric Peak Pressure (TPP)
- ∞ Static Acoustic Admittance (SA, Peak)
  - ∞ Peak Compliance
  - ∞ Static Compliance
- ∞ Tympanometric Width (TW)
  - ∞ Gradient (GR)

# Ear Canal Volume



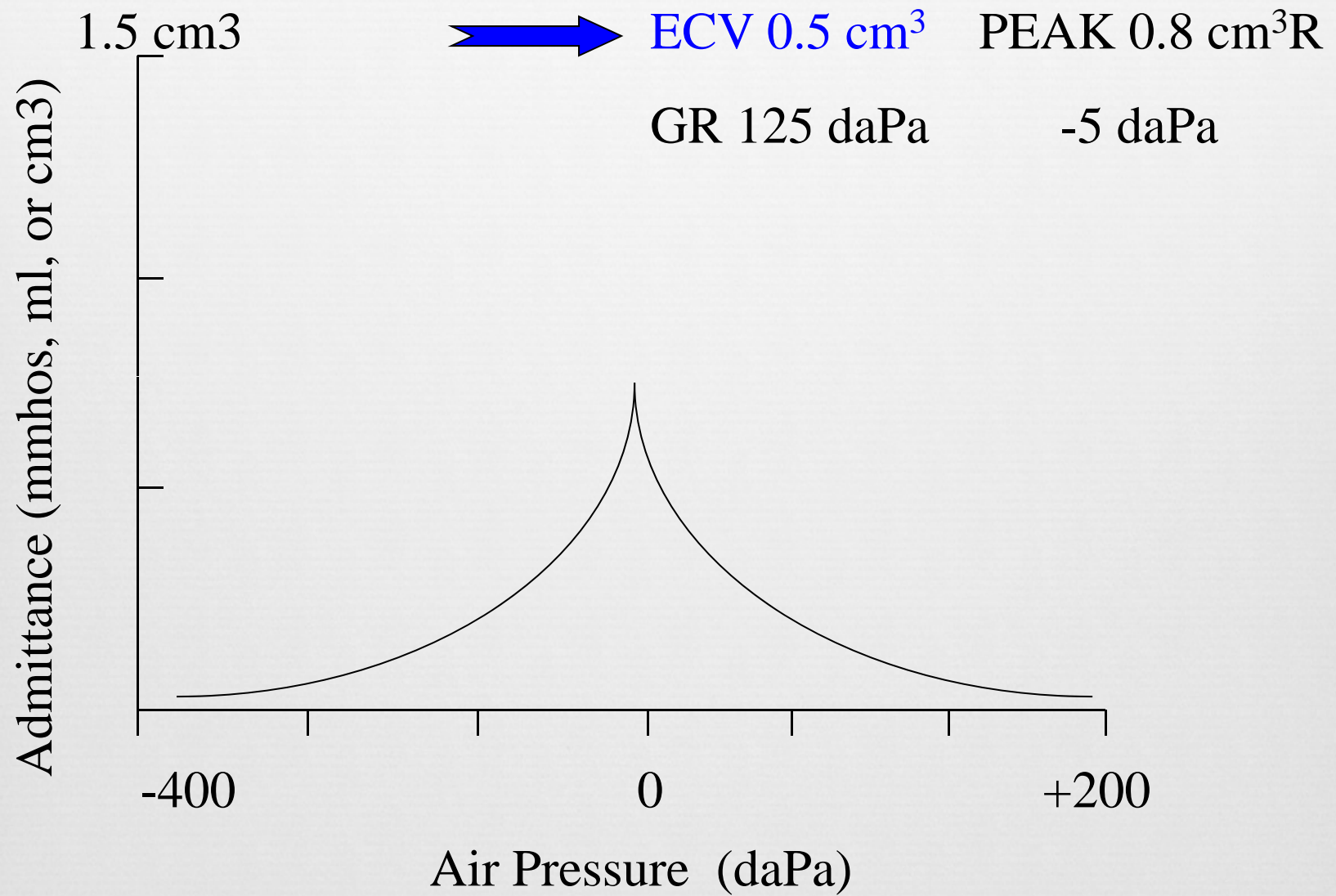
- ❧ Estimate of the volume between the probe tip and the tympanic membrane
- ❧ Use to assess tympanic membrane and ear canal status
  - ❧ No perforations, foreign bodies, tumors
  - ❧ Effects of surgeries/infections on ear canal and tympanic membrane
- ❧ Normative data

Adults	Children (6 wk-7 yr)	Children (post-tube)
0.63-1.46 cm <sup>3</sup>	.3-1.0 cm <sup>3</sup>	1.0-5.5 cm <sup>3</sup>

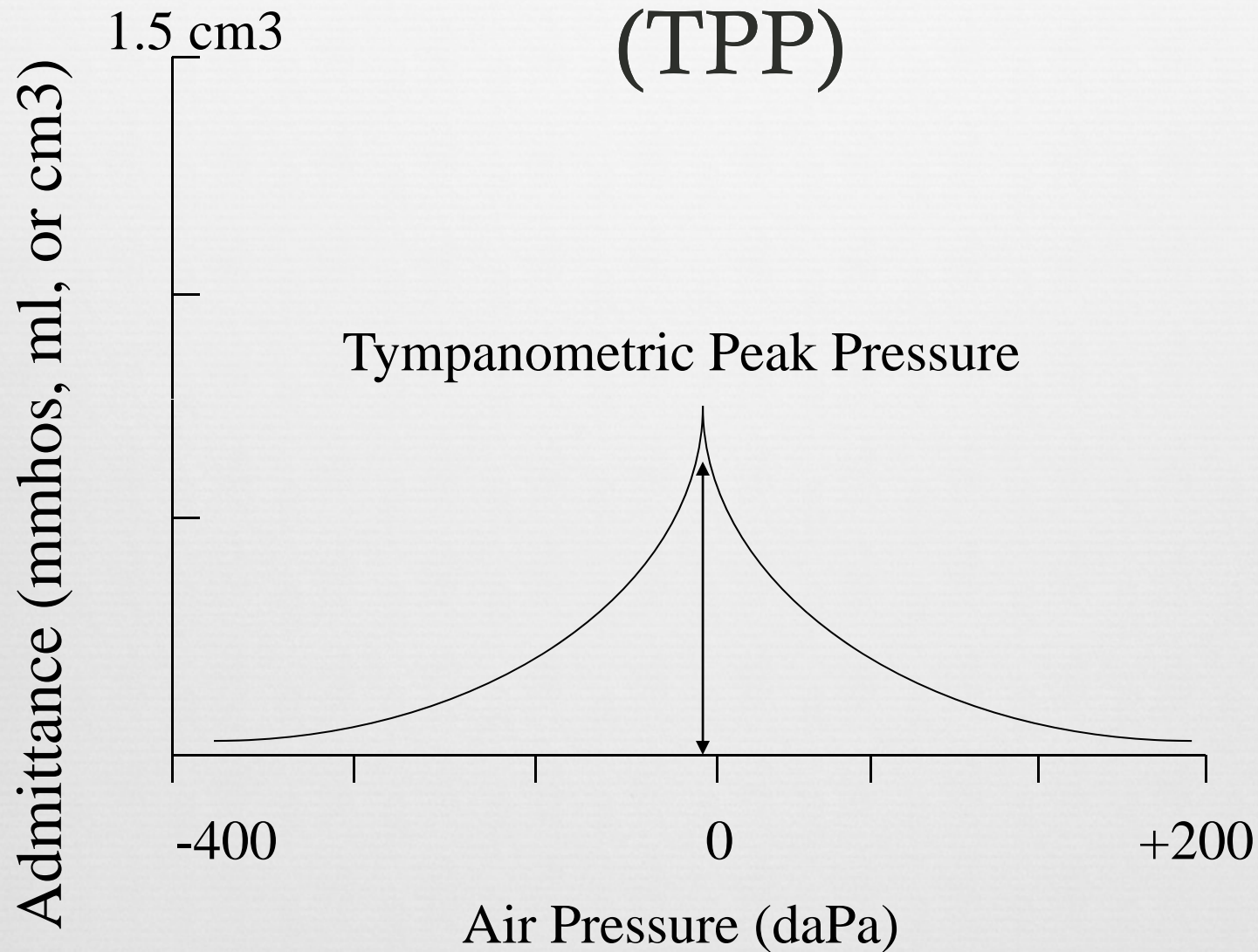
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Margolis & Heller, 1987; Shanks et al., 1992

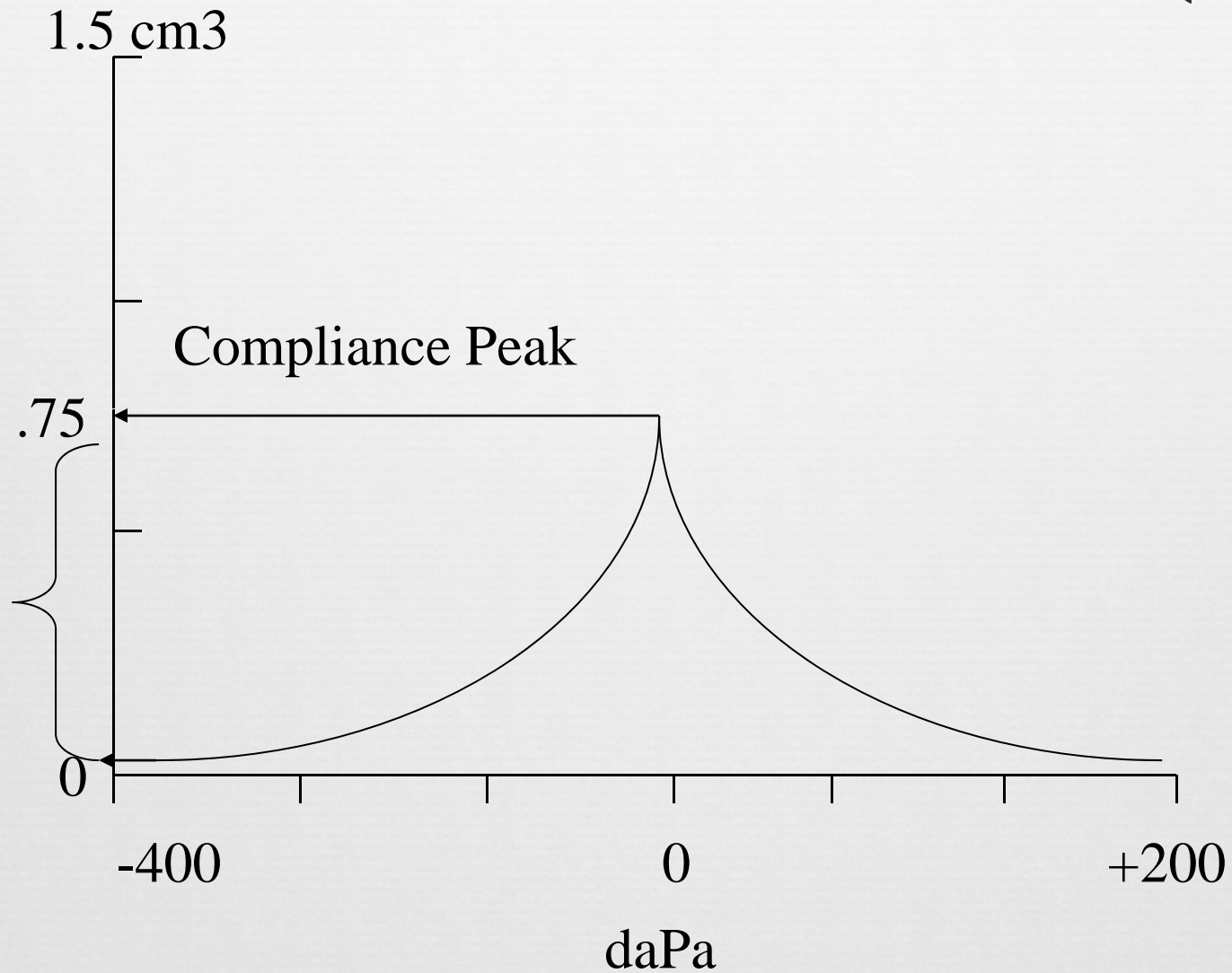




# Tympanometric Peak Pressure (TPP)

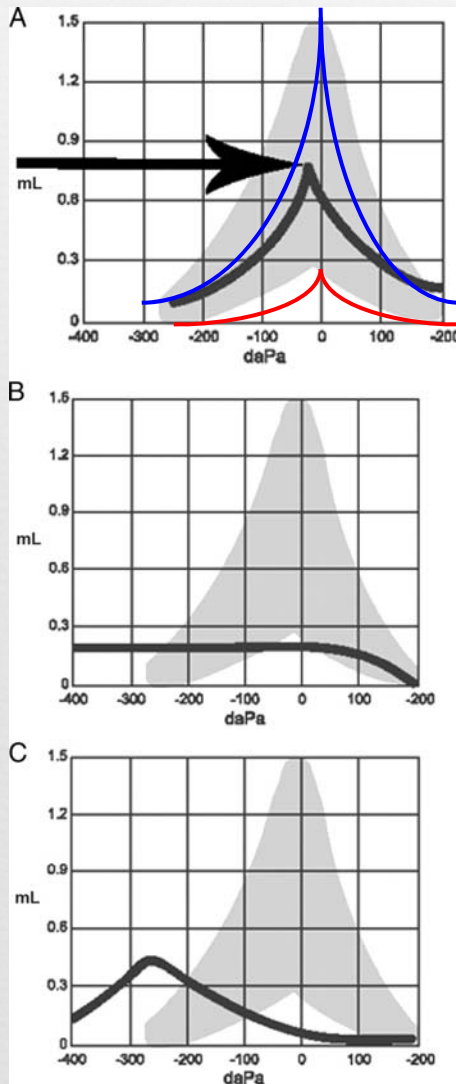


# Static Acoustic Admittance (SA)





# Etiologies



Type A



Normal

Type A<sub>d</sub>



Ossicular Discontinuity (scaling)

Type A<sub>s</sub>

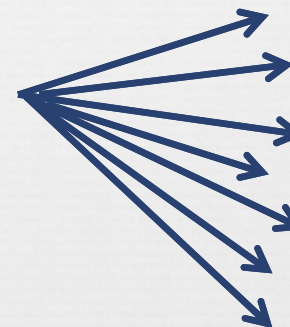


TM Scarring



Otosclerosis

Type B “Flat”



Otitis Media w/ Effusion

Occluded Cerumen

Probe against canal (ECV)

Perforation/Patent PE tube

Head Trauma

Otosclerosis

Cholesteatoma

Type C



ETD

Pre/Post OM

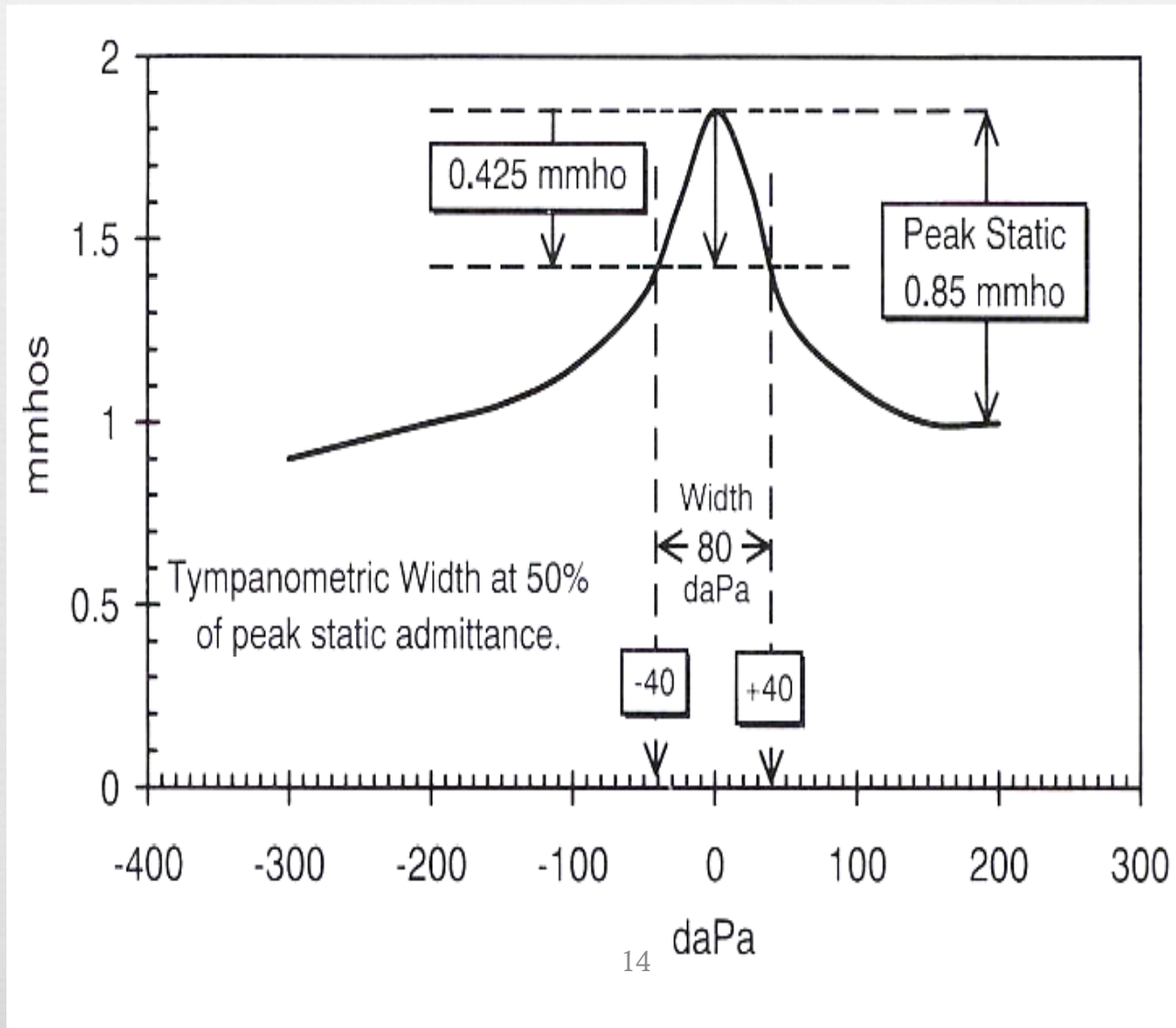
Barometric pressure changes

Figure 2. Tympanograms

# Normative Data for 226 Hz

Measure	Infants & Toddlers	School Children	Young Adults	Older Adults
Static Acoustic Admittance	.2 to .7	.4 to 1.4	.3 to 1.5	.2 to 1.5
Ear Canal Volume	.3 to 1.0	.6 to 1.4	.9 to 1.8	.9 to 2.0
Tympanometric Width	102 to 204	60 to 168	36 to 95	35 to 125
Tympanometric Peak Pressure	N/A	N/A	N/A	N/A

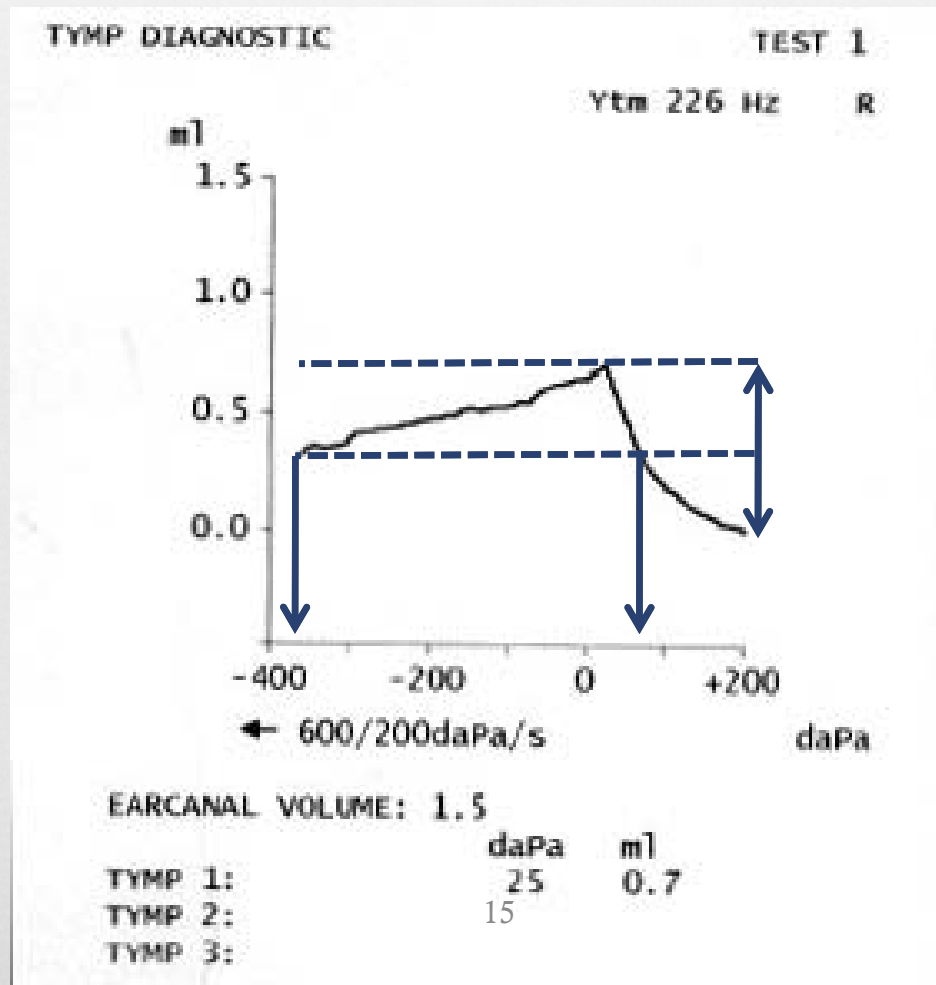
# Tympanometric Width (TW) or Gradient (GR)





# What Type is This???

12 year old female



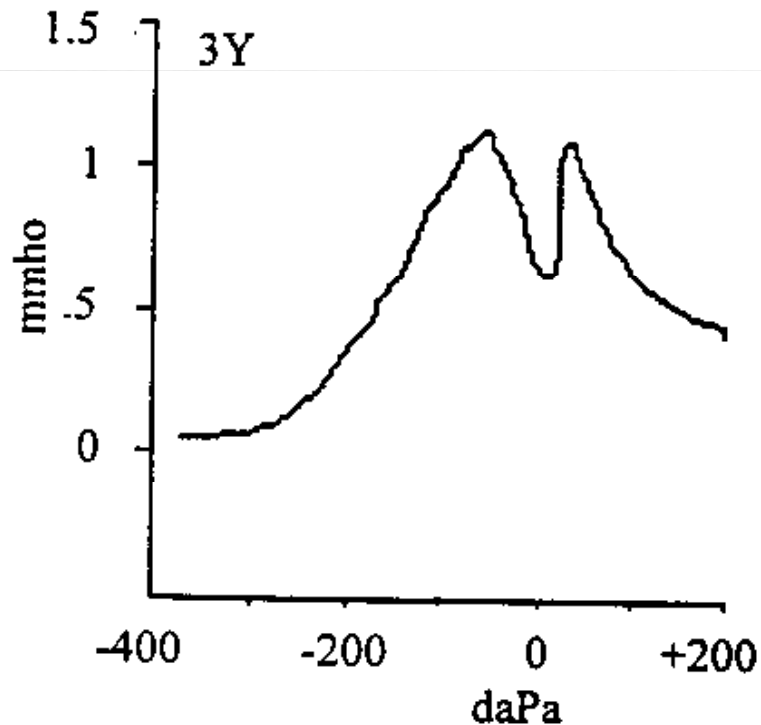
$/75 / + / -375 / =$   
**450 daPa!**

# Infant vs. Child vs. Adult Testing



- ⌘ Mature ears = 226 Hz; Infants (< 7 mo) = 1000 Hz
- ⌘ Anatomical differences between ears
- ⌘ Ear Canal/Middle Ear Characteristics
  - ⌘ Infant ear canals are cartilaginous and do not ossify until at least 4 months of age
  - ⌘ The middle ear space is smaller in volume and may contain mucus and mesenchyme
  - ⌘ These differences make the **mass** and **resistive components** more prominent in infants than adults
  - ⌘ Vibratory motion of the external ear may add to the resistive component

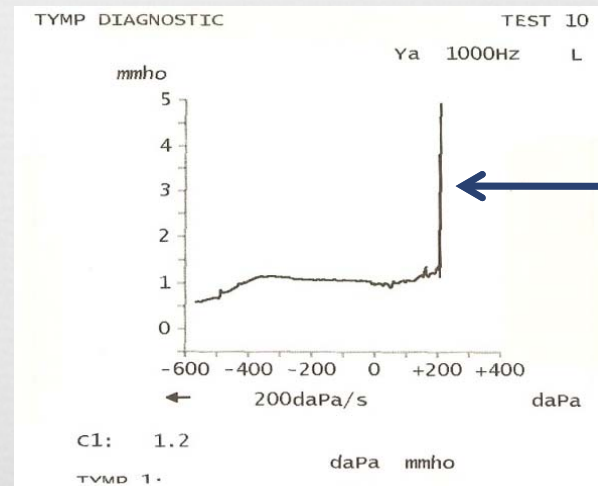
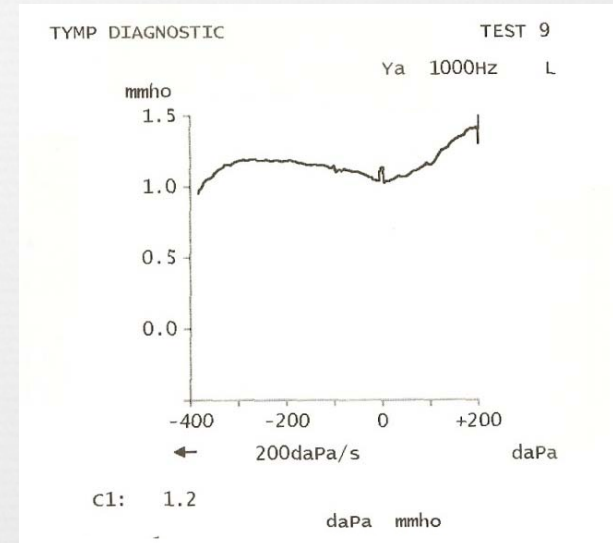
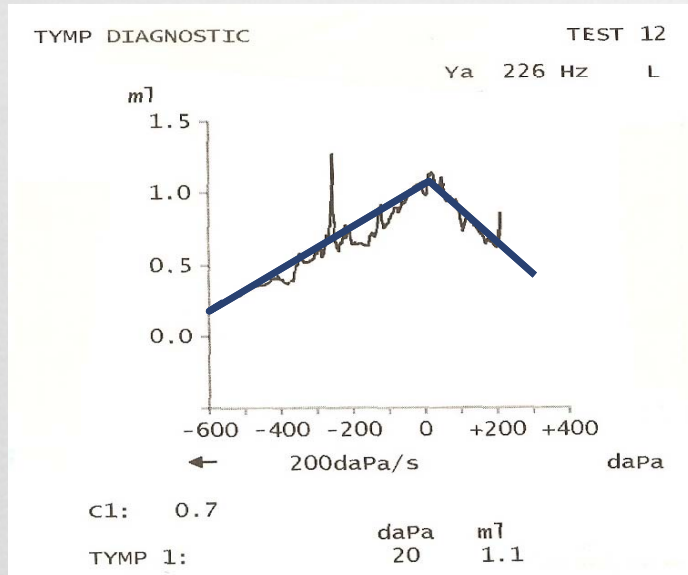
# How does these factors effect 226 Hz Tympanogram?



- Usually results in a normal or notched tympanogram, **even if there is middle ear effusion** in infants under 6 months of age



# Example: 2 month old



Child  
Movement

# 1000 Hz Norms



Measurement	Kei et al., 2003	Margolis et al., 2003	Kleindienst et al., 2009
Ear Canal Volume (cm <sup>3</sup> )	N/A	N/A	0.16 to 0.36
Static Acoustic Admittance (mmho)	0.39 to 2.12 (+200)	0.6 to 4.3 (-400)	0.73 to 2.25 (-400)
Tympanometric Peak Pressure (daPa)	-58.0 to 86.6	-133 to 113	-86.5 to 77

Kei et al., 2003 (1-6 d/o); Margolis et al., 2003 (2-4 wks CA);  
Kleindienst et al., 2009 (12-60 h/o)

# Equipment



- ❧ Manufacturers
  - ❧ GSI/Welsh Allyn (4 models)
  - ❧ Madsen (3 models)
  - ❧ Maico (6 models)
  - ❧ Interacoustics (3 models)
  - ❧ Ear Check

# Grason Stadler (GSI)/Welsh Allyn



MicroTymp 3



TympStar



GSI 38



GSI 39



# Madsen



OtoFlex 100



Zodiac



Capella

# Maico



Otowave



MI 24



MI 44



MI 34



MI 26

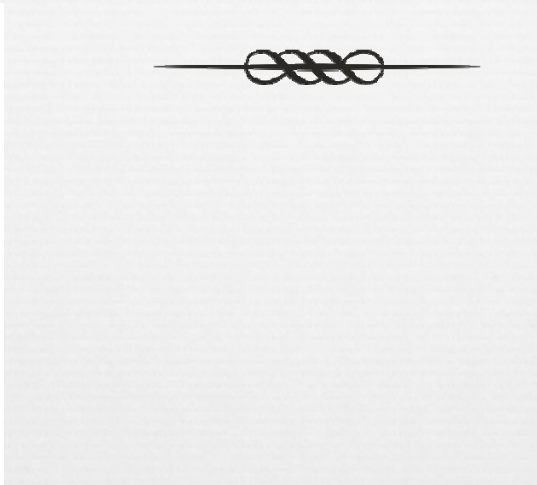


Race car audiotymp

# Interacoustics



Titan



AT235H



MT10



# Ear Check





# Conclusions



## ❧ Take Home Messages

- ❧ Tympanometry is an essential tool in combination with otoscopy for diagnosing middle ear pathology
- ❧ Tympanometry is quick, easy, and affordable
- ❧ Audiological management is recommended for pediatrics with middle ear pathology
  - ❧ Obtain definitive hearing evaluation
  - ❧ Monitor for speech-language delay
- ❧ The equipment you buy will depend on your practice needs....work with your local audiologist!

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# Questions/Comments





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