

1000 Hz Tympanometry: Uses and Abuses



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What is the Prevalence of Middle Ear Effusion in Infants?

- Full term babies (Well babies)
 - Prevalence of conductive hearing loss is 17 per 1000 (RIHAP, White et al., 1994)
- NICU babies (Premature, Sick babies)
 - Prevalence of conductive hearing loss is 36 per 1000 (RIHAP, White et al., 1994)



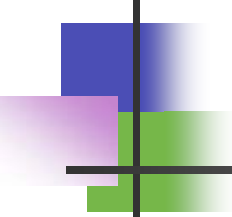
What is the Prevalence of Middle Ear Effusion in Infants?

- Roberts et al. (1995) report high rate of MEE (amniotic fluid) on day 1 in normal newborns
- Paradise et al. (1997) report prevalence of MEE at 3 months of age
 - 15% suburban
 - 33% urban



Prevalence Possibly Associated With Length of Stay in NICU

- Sutton et al. (1996) found that infants in the NICU >30 days had 4 times the risk of having abnormal tympanograms (678 Hz probe tone)
- Yoon et al. (2003) found that of 82 NICU graduates, 37% later had abnormal tympanometry in one ear with 29% having abnormal tympanograms AU



Those children whose MEE is not resolved are at developmental risk

- Infants failing NHS due to conductive loss are at high risk for persistent or fluctuant mild to moderate hearing loss
- In the RIHAP studies, conductive losses ranged from 15-45 dB HL with a mean of 30 dB for 500-4000 Hz
- Doyle et al. (2004) found that 58% of neonates identified with effusion within the first 48 hours of life went on to have chronic otitis media during the first year of life with thresholds exceeding 25 dBHL at 1, 2 and 4 KHz (by 9 months of age)



Importance of Identifying Conductive Hearing Loss

- OAE results are influenced by the presence of MEE
- TEOAEs are absent in approximately 70% of children with abnormal tympanometry (Koivunen et al., 2000; Ho et al., 2001)
- If using OAEs as primary screening assessment, a significant percentage of the failures may due to MEE (Sutton, Gleadle & Rowe, 1996)



The Purpose

- What tympanometry protocols are being used with infants?
- Is the 1000 Hz probe tone in use?

Our Respondents

- Sent survey via email on:
 - EHDI listserve
 - Educational Audiology Association listserve
 - AAA "SoundOff" listserve
- 153 audiologists responded

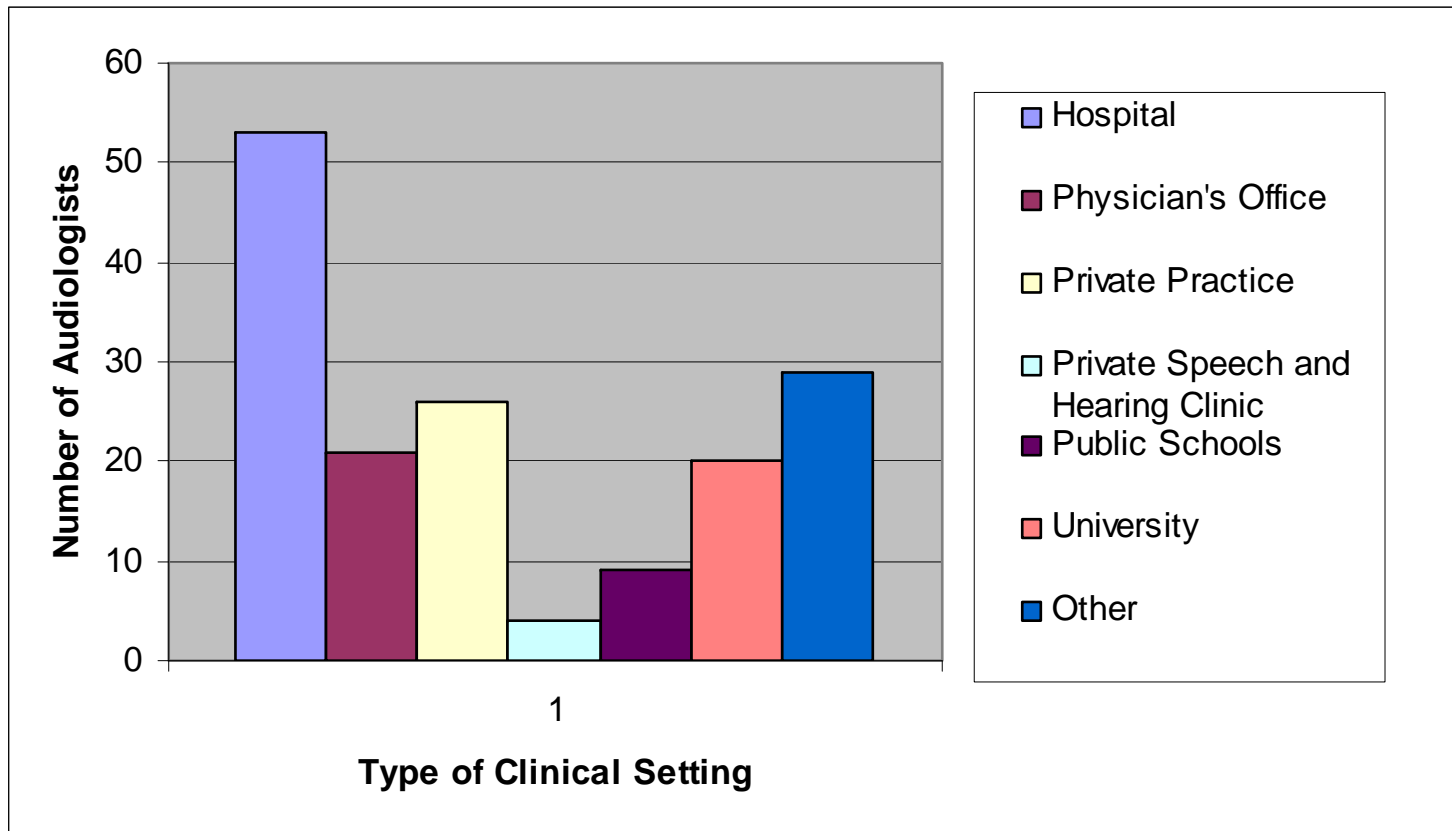


The Survey

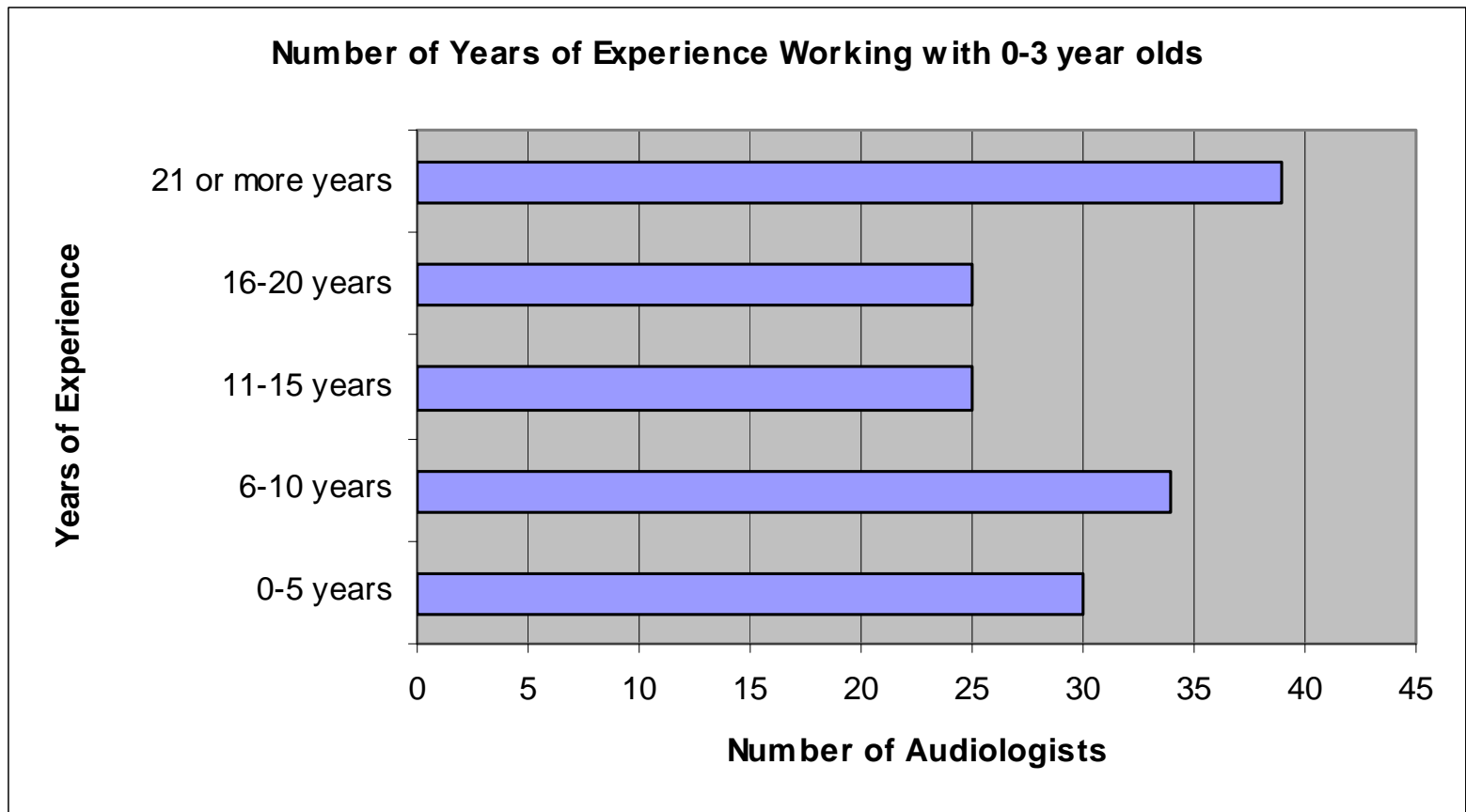
- Began with demographics
 - 13% male; 87% female
 - 35 states, Washington D.C., and the Northern Mariana Islands represented



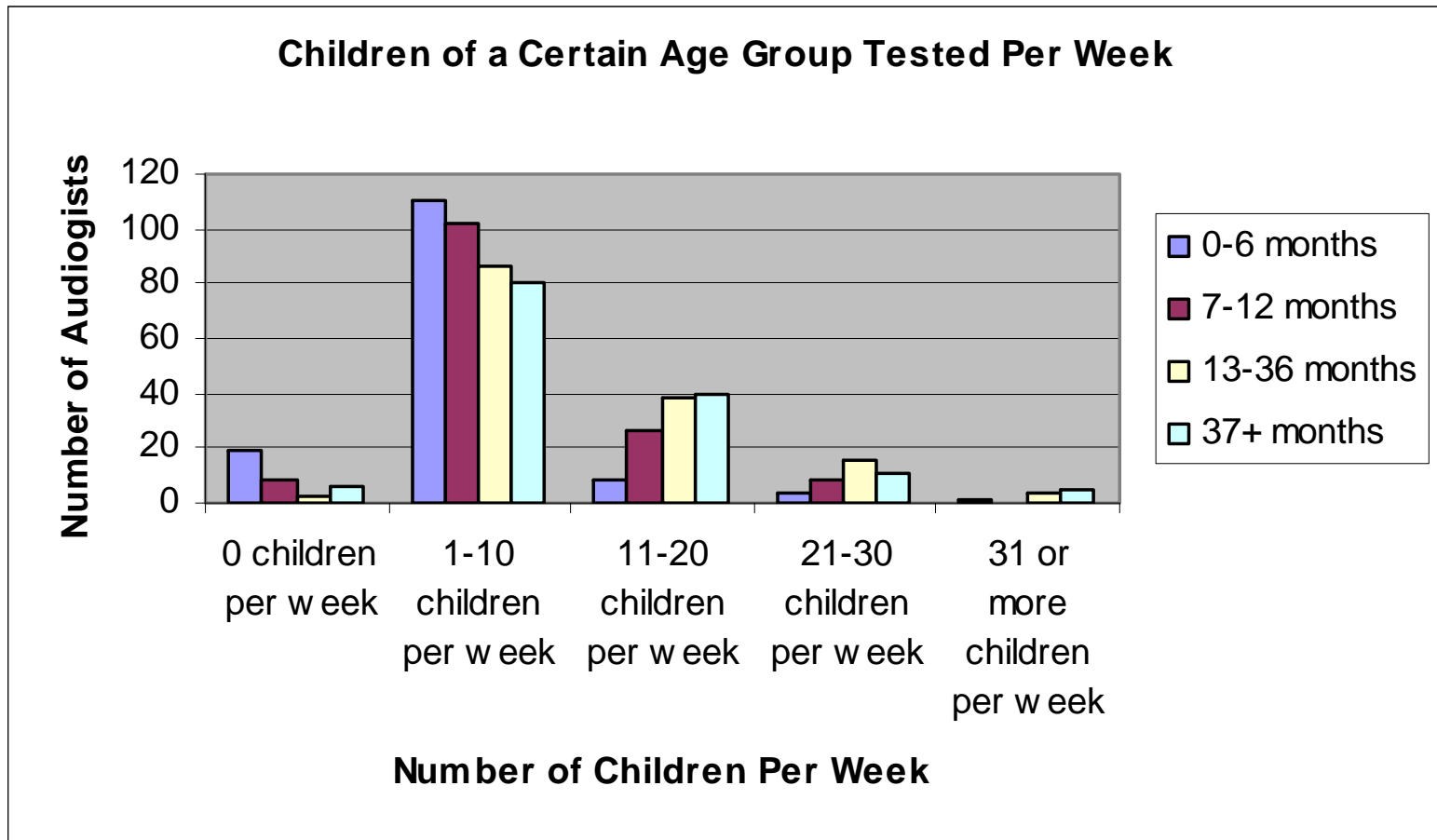
Demographics – Practice Setting



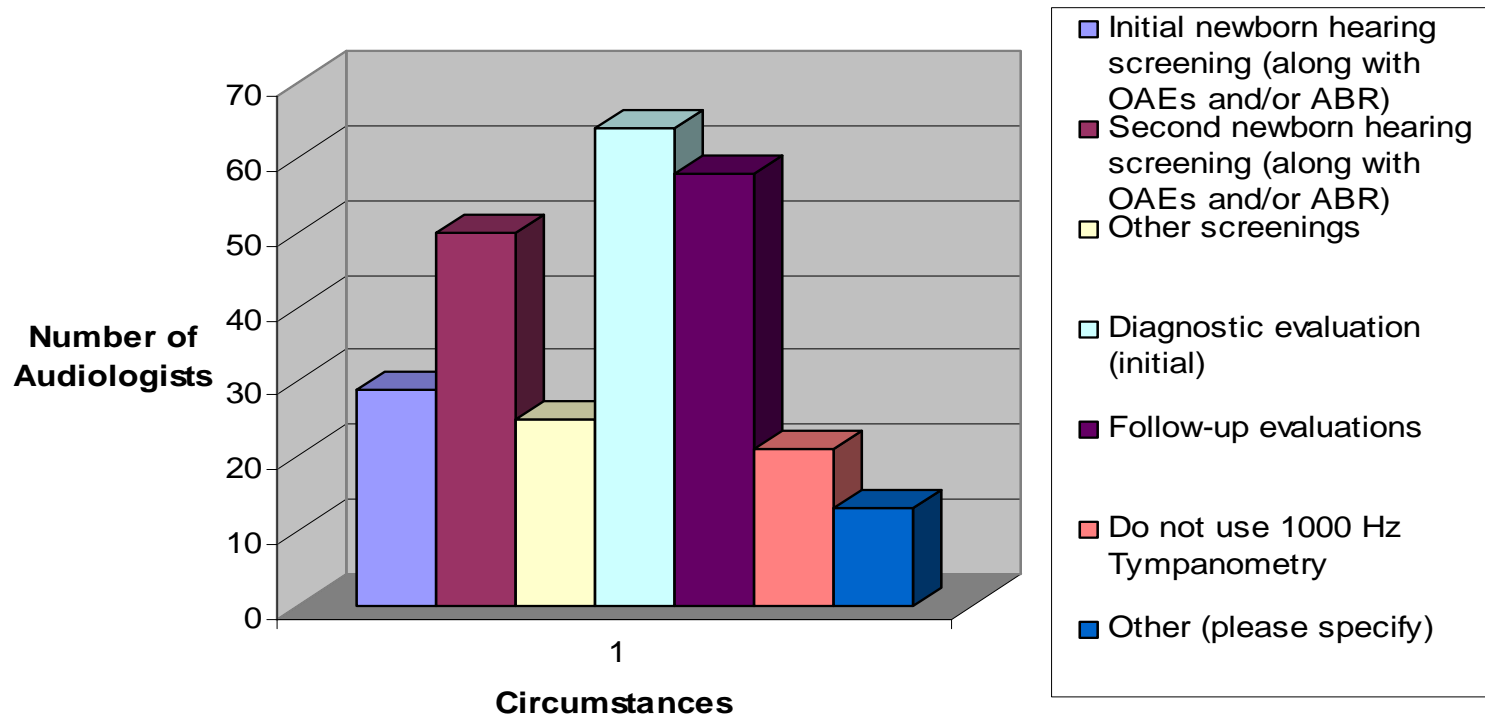
Experience with 0-3 Year Olds



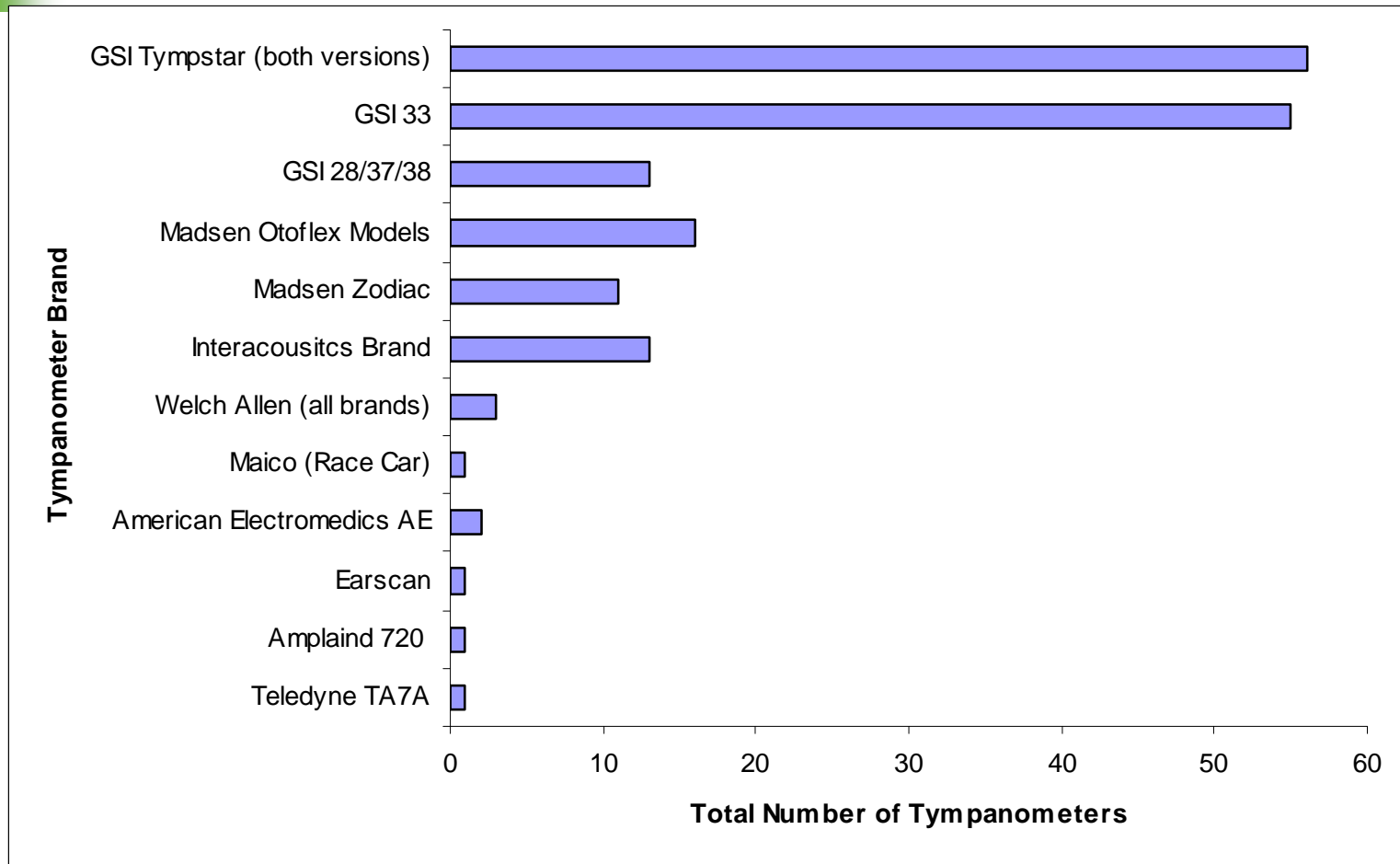
Experience – How Many Children Per Week?



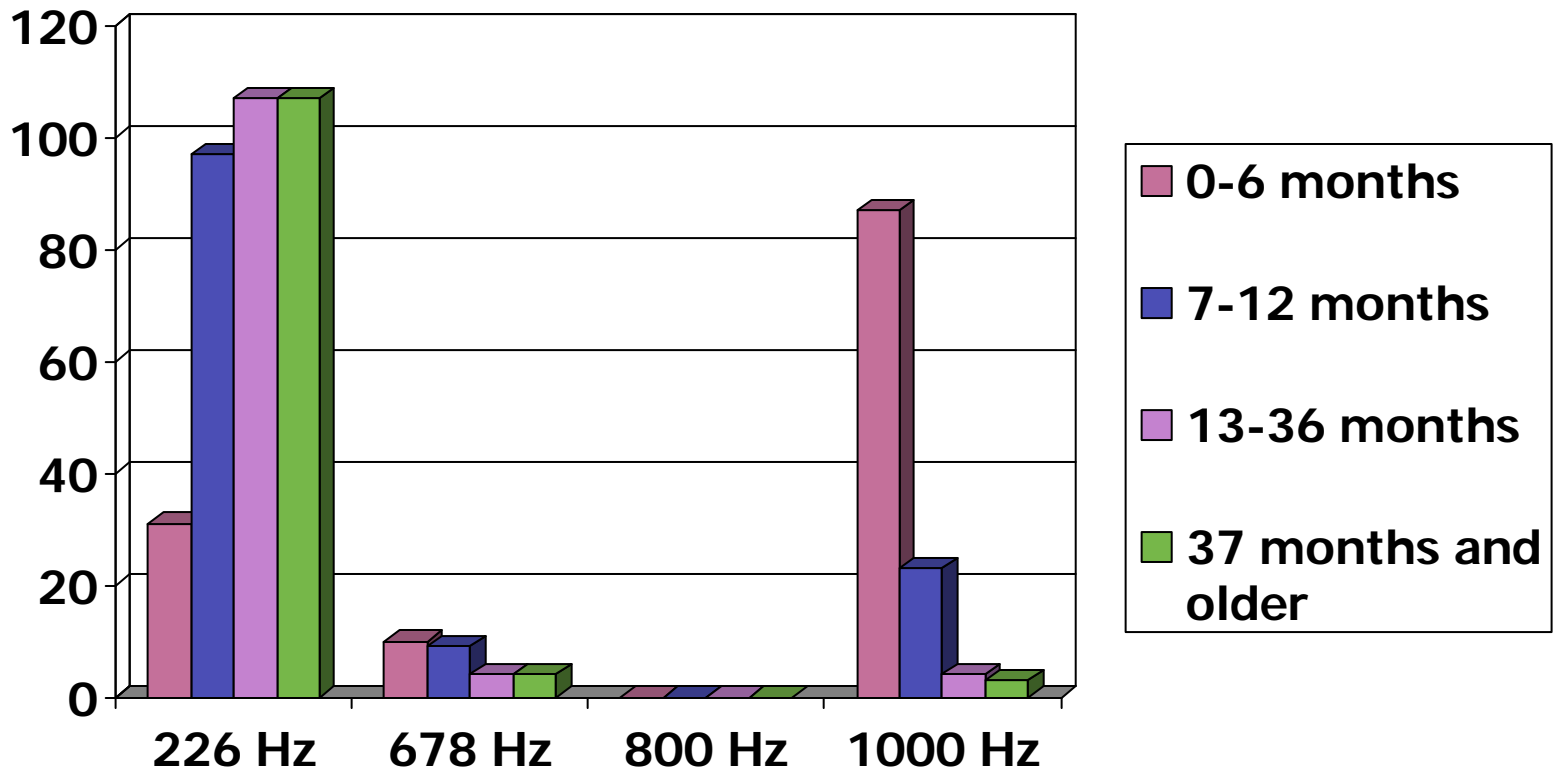
1000 Hz Probe Tone Use



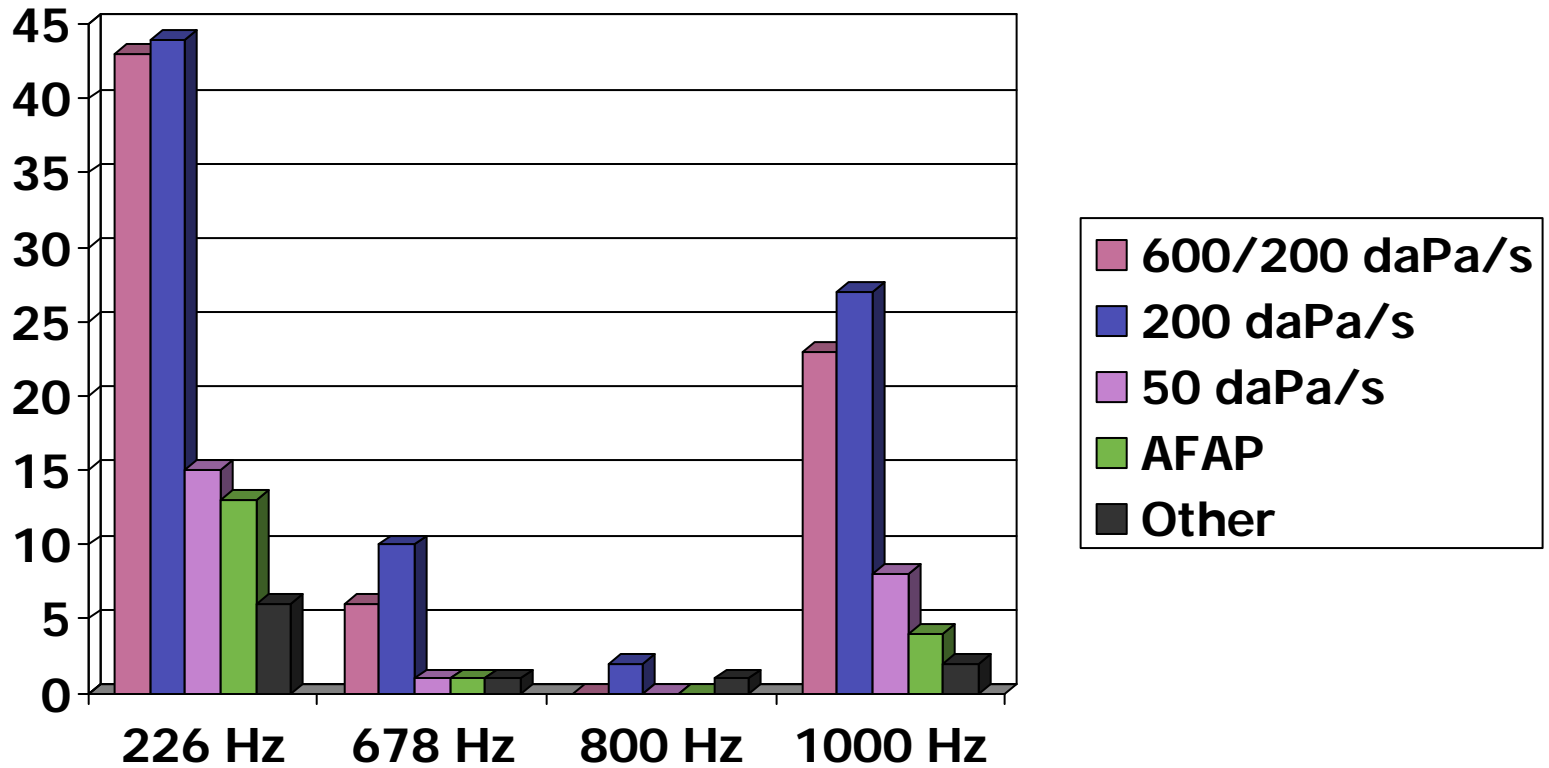
Equipment Used...



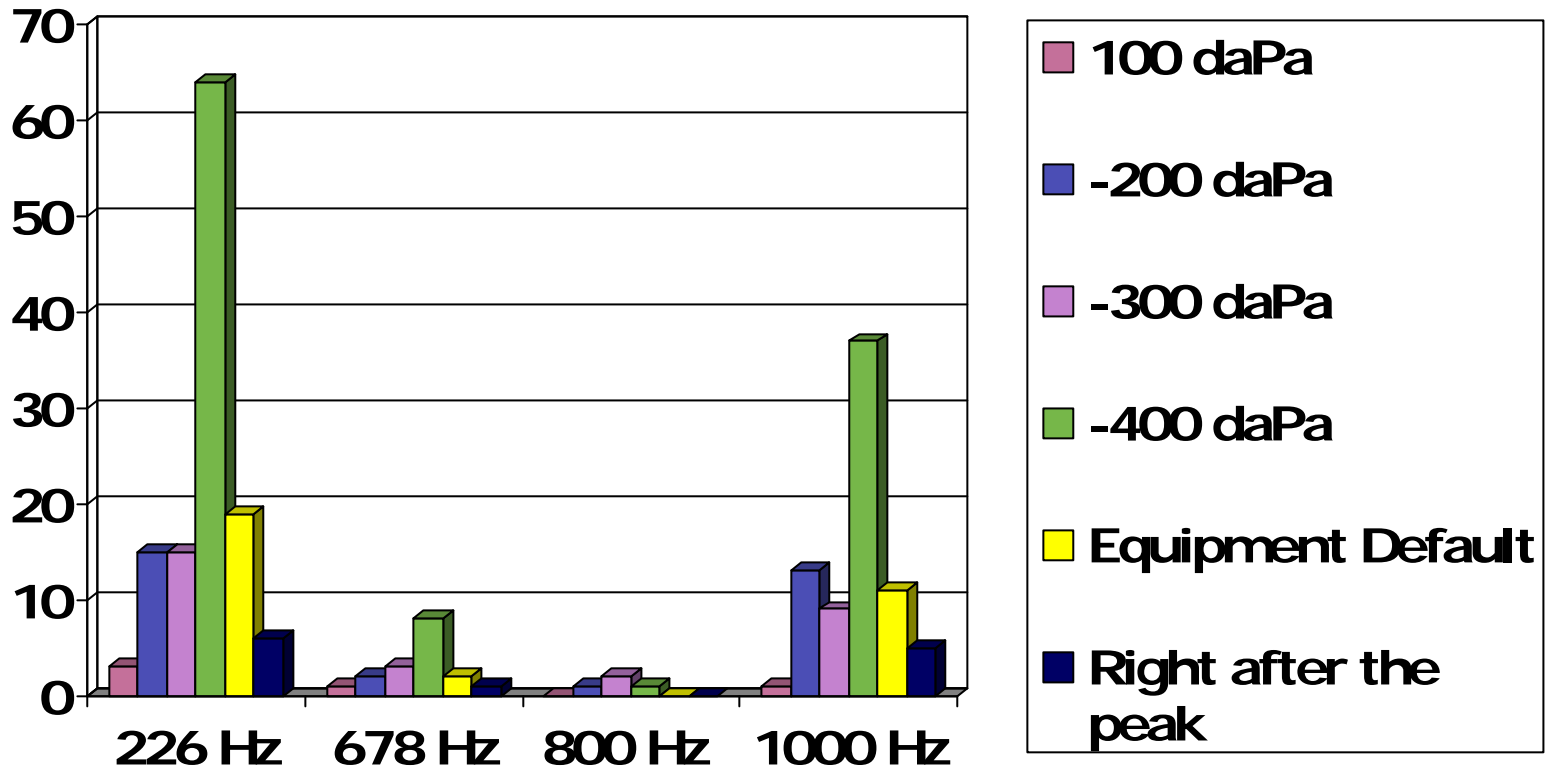
Probe Tones by Age



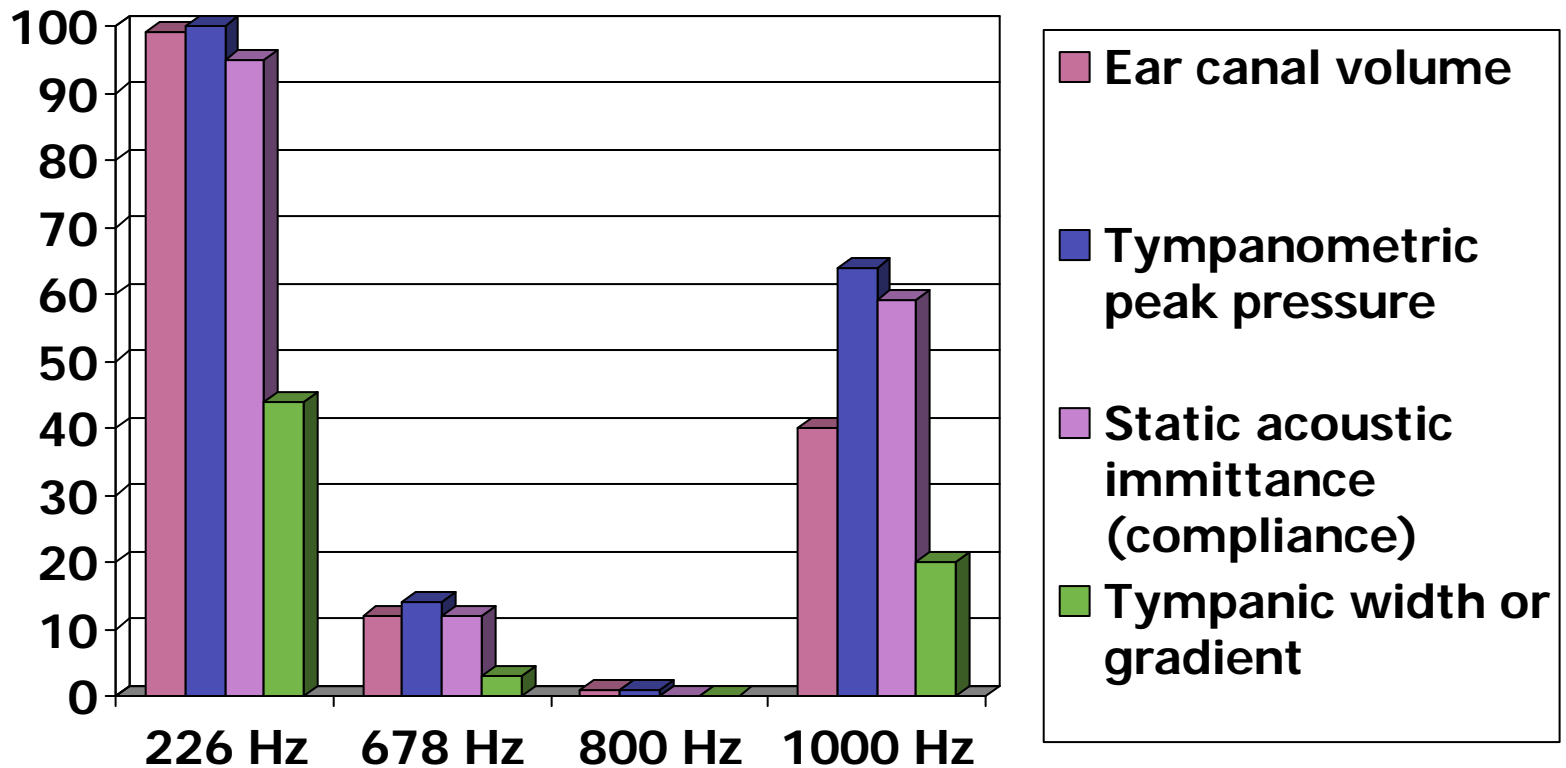
Parameters - Pump Speed



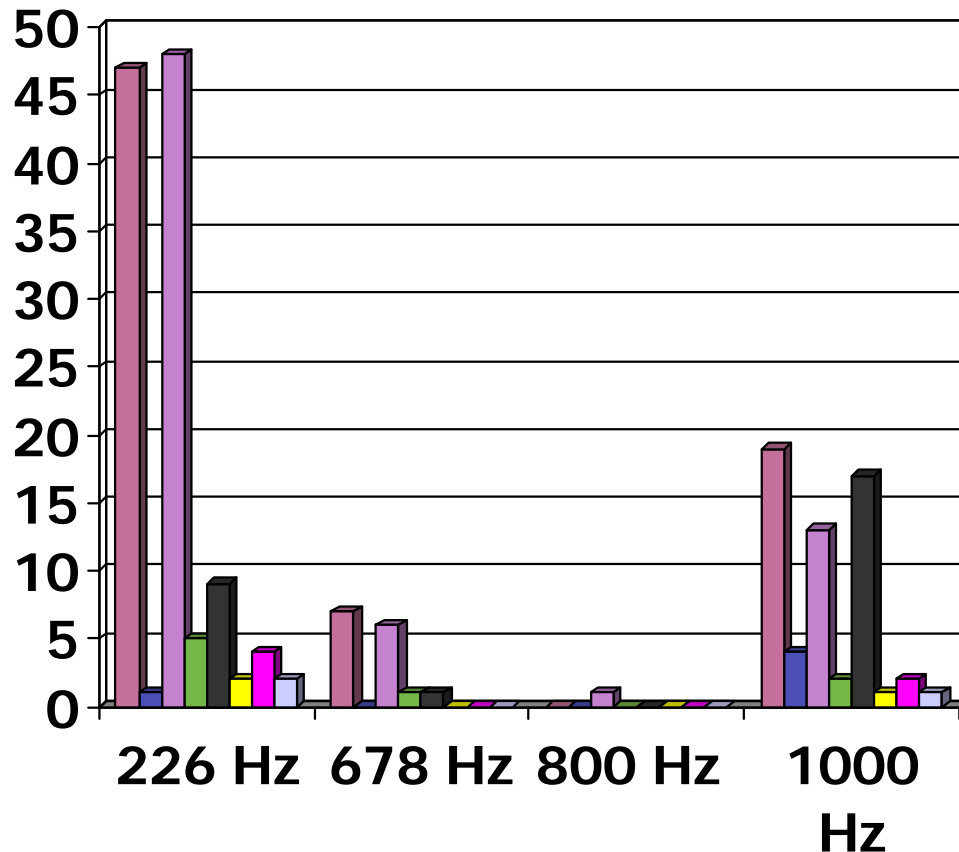
Parameters – Stopping Pressure



Parameters used to Determine if Tympanogram is Normal

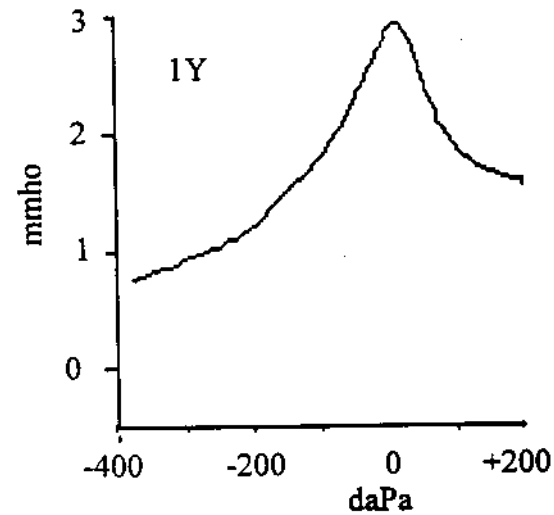
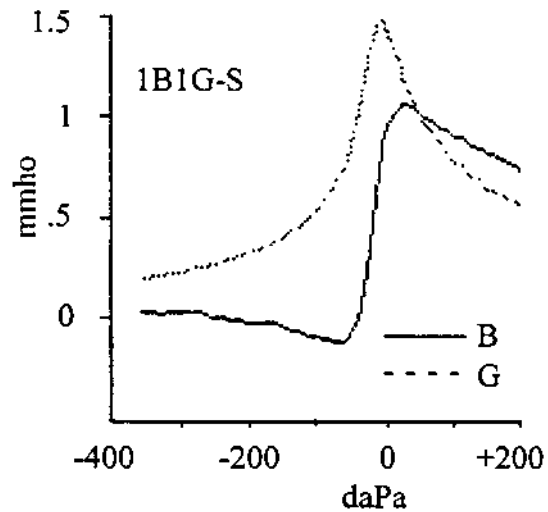
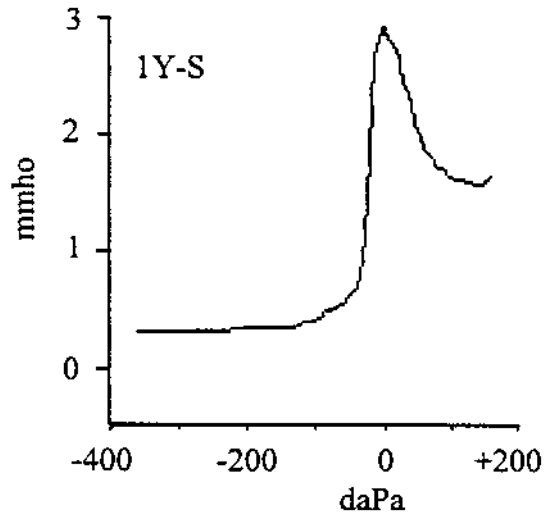


Norms Used



- ASHA Screening Guidelines
- Kei et al. 2003
- Jerger Types
- Margolis & Heller 1986
- Margolis et al. 2003
- Nozza et al. 1992
- Nozza et al. 1994
- Roush et al. 1995

How Do I Interpret 1000 Hz Tympanograms?





Peak Static Acoustic Admittance (SAA)

- Some call it Static Acoustic Compliance (SAC)
- Based on the calibrated equivalent ear canal volume
 - 2cc or 2 ml for 226 Hz probe tone
 - 3 times larger for 678 Hz
 - 4.4 times larger for 1000 Hz

Peak Static Acoustic Admittance



- Positive vs. Negative Tail
 - Research shows that negative tail gives the most accurate measurement
 - Equipment manufacturers use the tail of the starting (initializing) pressure



Why Is Peak Static Acoustic Admittance Important?

- Altered by ear disease
 - Increases with discontinuity
 - Decreases with space occupying lesion in the middle ear

Recent Research Data Reveals...



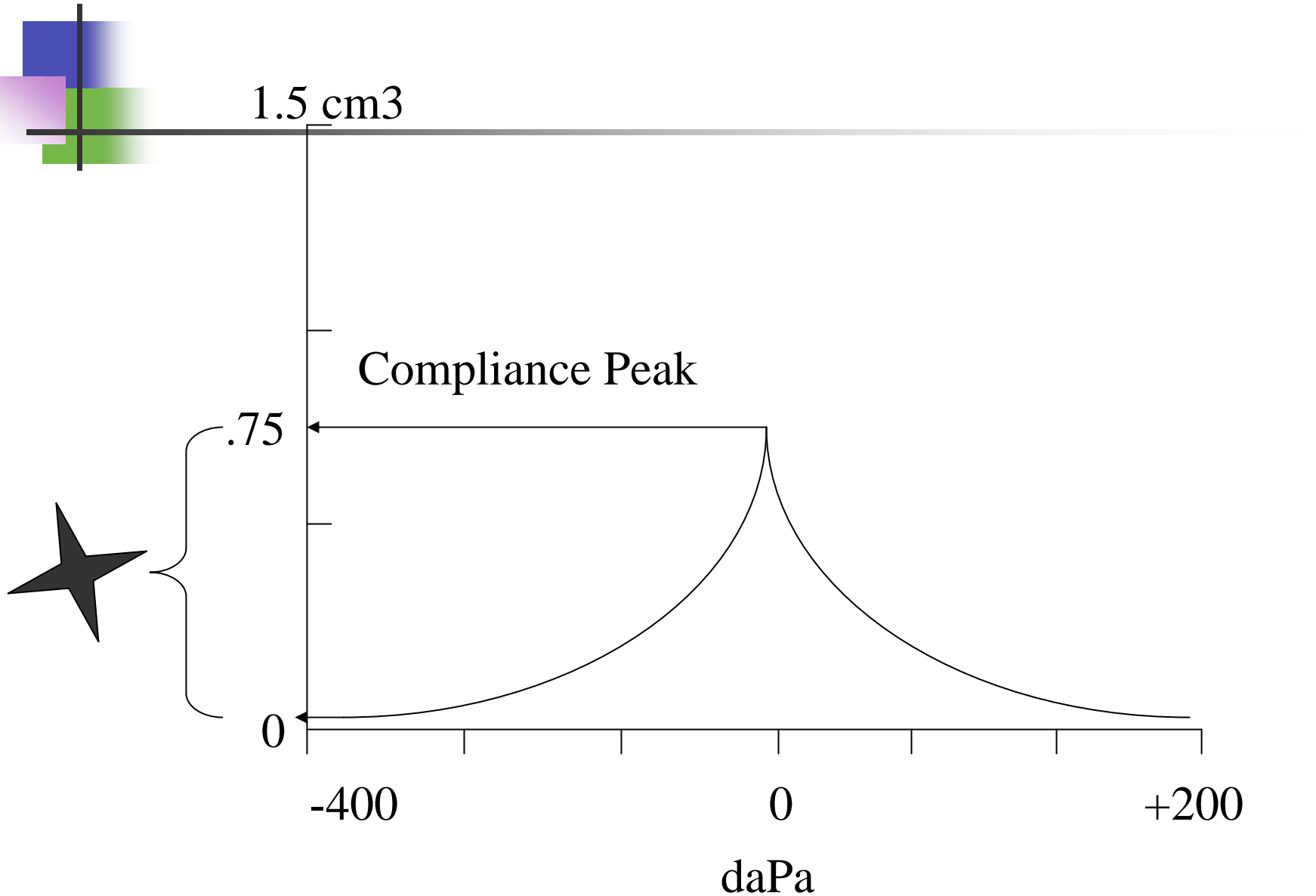
- MUST have defined PEAK to use these...
- Margolis, Bass-Ringdahl, Hanks, Holte, & Zapala (2003)
 - 5th percentile for NICU babies and full-term babies is .6 mmhos (peak to negative tail)
- Kei, Allison-Levick, Dockray, Harrys, Kirkegard, Wong, Maurer, Hegarty, Young, & Tudehope (2003)
 - 5th percentile for full-term babies is .39 mmhos (peak to positive tail)

Recent Research Data Reveals...



- MUST have defined PEAK to use these...
- Swanepoel, Werner, Hugo, Louw, Owen, & Swanepoel (2007)
 - 5th percentile for full-term babies is 1.4 mmhos (uncompensated peak static admittance)
 - Correlates well with Margolis et al. study
 - Revealed age and gender differences
 - Further study is needed for this method of evaluation

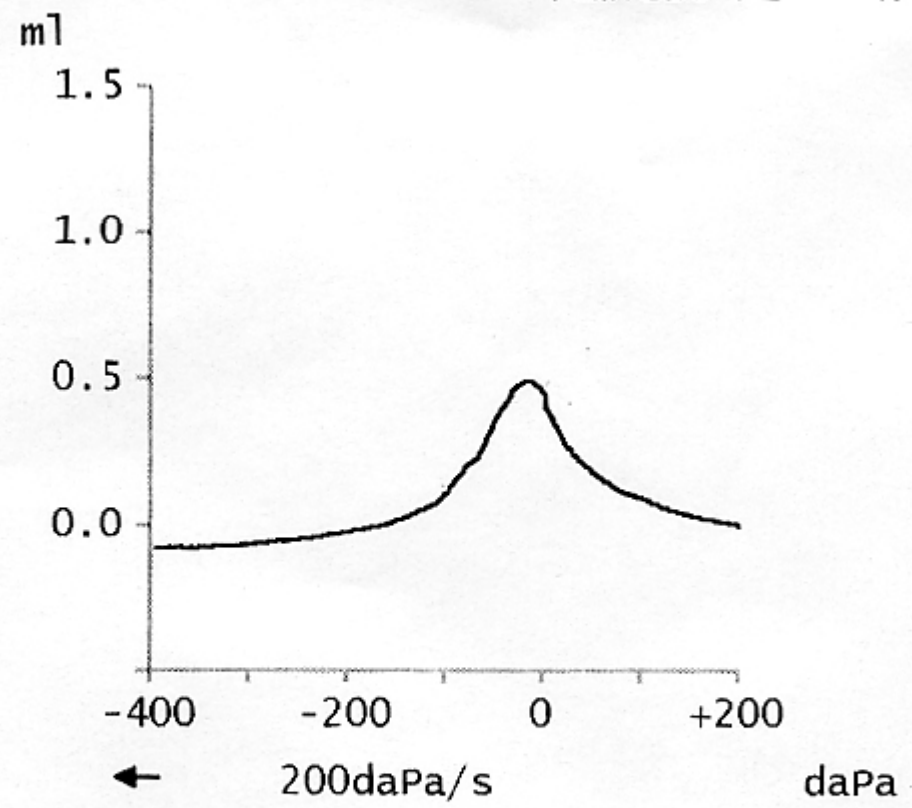
Peak Static Acoustic Admittance



TYMP DIAGNOSTIC

TEST 2

Ytm 226 Hz R



EARCANAL VOLUME: 0.6
daPa

TYMP 1: -15 ml
TYMP 2: 0.5
TYMP 3:

GRADIENT: 95 daPa

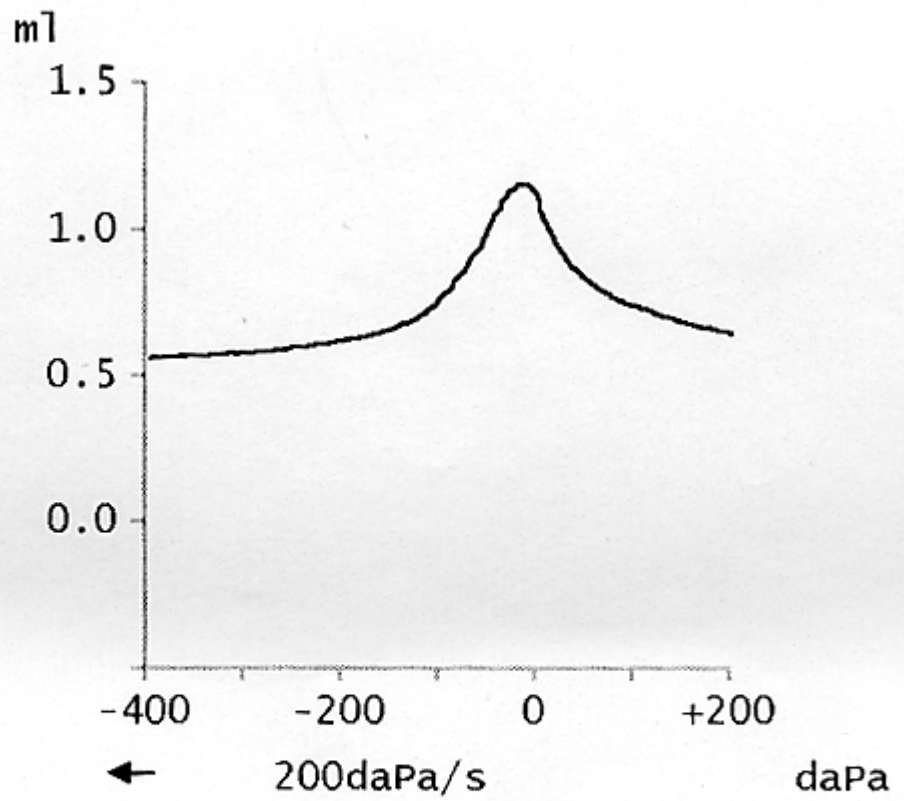
Compensated
or
Baseline-On

226 Hz

TYMP DIAGNOSTIC

TEST 3

Ya 226 Hz R



C1: 0.6

daPa ml
-10 1.2

TYMP 1:
TYMP 2:
TYMP 3:
GRADIENT:

100 daPa

Non-Compensated or Baseline-Off

226 Hz

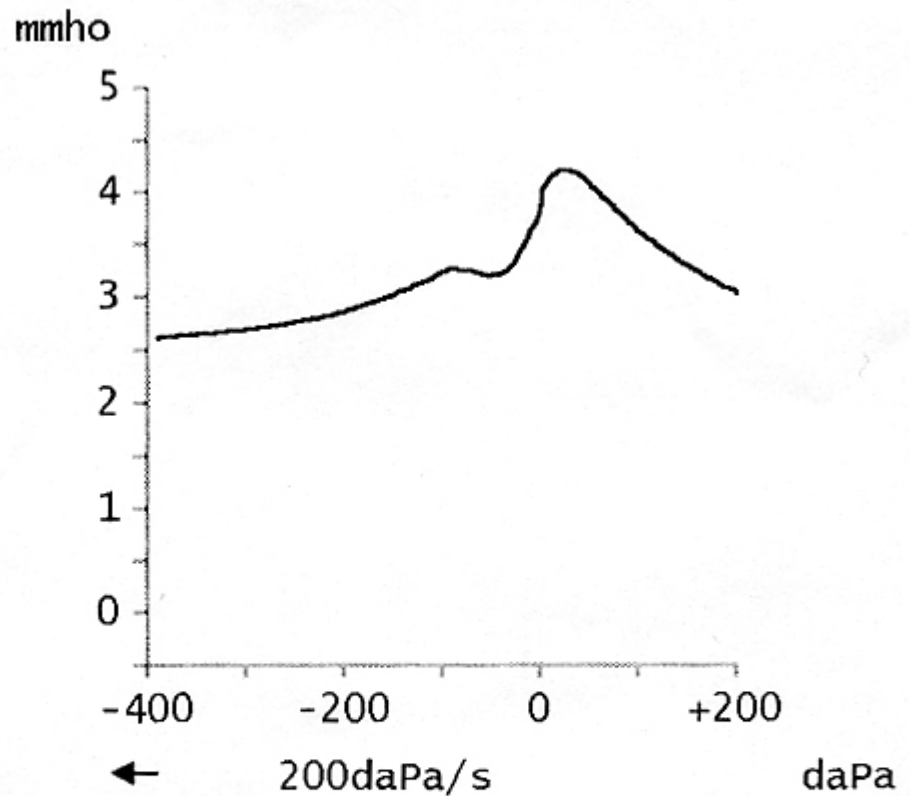
Non-Compensated
or
Baseline-Off

1000 Hz

TYMP DIAGNOSTIC

TEST 4

Ya 1000Hz R



c1: 3.0

TYMP 1:
TYMP 2:
TYMP 3:

daPa mmho



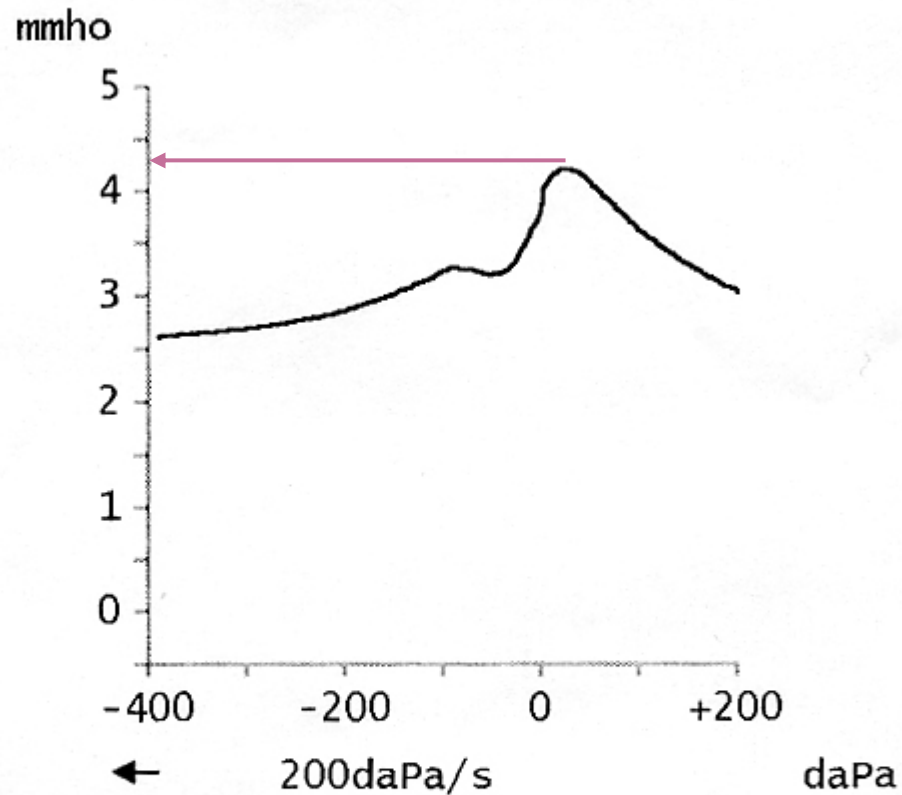
Non-Compensated
or
Baseline-Off

1000 Hz

TYMP DIAGNOSTIC

TEST 4

Ya 1000Hz R



C1: 3.0

daPa mmho

TYMP 1:

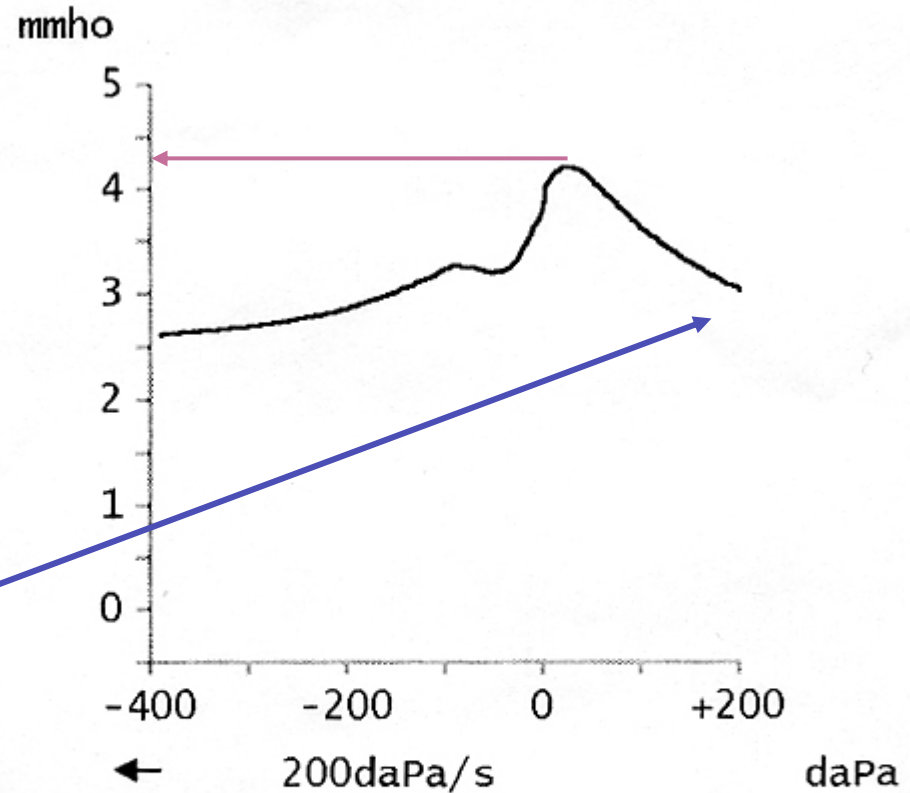
TYMP 2:

TYMP 3:

TYMP DIAGNOSTIC

TEST 4

Ya 1000Hz R



Positive Tail

Peak = 4.3
-ECV = 3.0

SAA = 1.3
Also called
SAC

c1: 3.0

daPa mmho

TYMP 1:

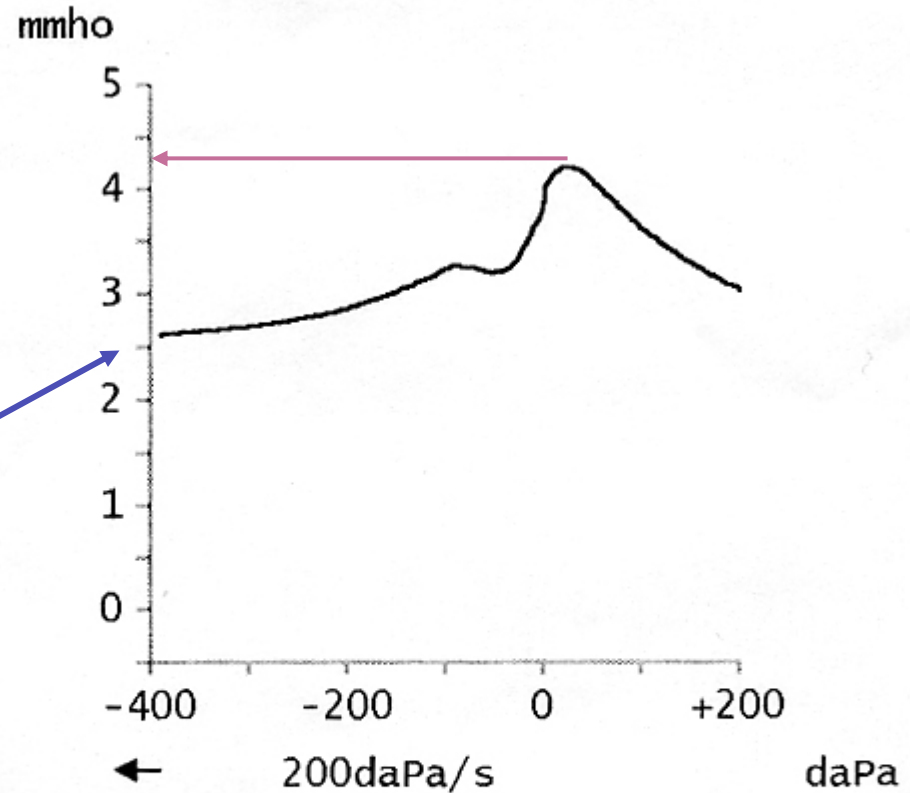
TYMP 2:

TYMP 3:

TYMP DIAGNOSTIC

TEST 4

Ya 1000Hz R



c1: 3.0

daPa mmho

TYMP 1:

TYMP 2:

TYMP 3:

Negative Tail

Peak = 4.3

-ECV = 2.6

SAC = 1.7

SAA

Factors that Influence Infant Assessment

Why 1000 Hz instead of 226 Hz?

- 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 mesenchyme
 - Vibratory motion of the external ear may add to the resistive component
 - These differences make the mass and resistive components more prominent in infants than adults

Factors that Influence Infant Assessment

Probe Says "Leak" or "Occluded"

■ Ear Canal Volume Too Small

- Altitude (4950 ft.)
 - Adjustments in calibration based on adult ears
 - May not affect tympanograms from adults, but may affect infants
- Rounding Procedure
 - Rounds ear canal volume to the nearest tenth
 - Volume increases with frequency, not always proportionately
- Fluid in the middle ear may be pushing out on TM, making ear canal volume even smaller



Factors that Influence Infant Assessment

Probe Says "Leak" or "Occluded"

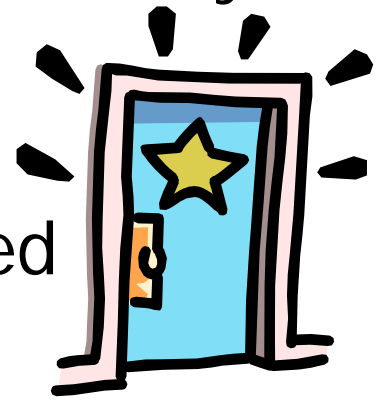
- Shape of the neonatal ear canal
 - Slit-like, not as cylindrical as adults
 - Probe Placement
 - Standing Waves Rounding Procedure



Factors that Influence Infant Assessment

Probe Says "Leak" or "Occluded"

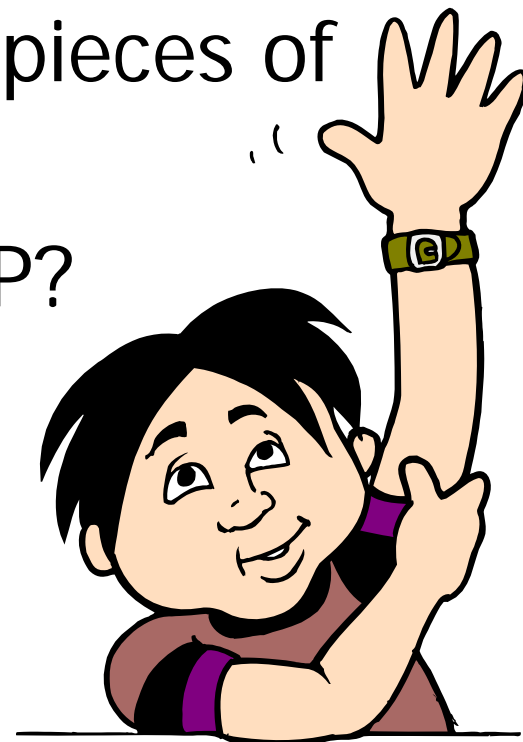
- Room noise in NICU or Well-Baby Areas
 - Close to probe frequencies, may interfere
 - GSI 33/ TympStar may interpret as feedback
 - As probe frequency increases, intensity of the output decreases
 - Room noise adds intensity; equipment interprets as occluded



Factors that Influence Infant Assessment

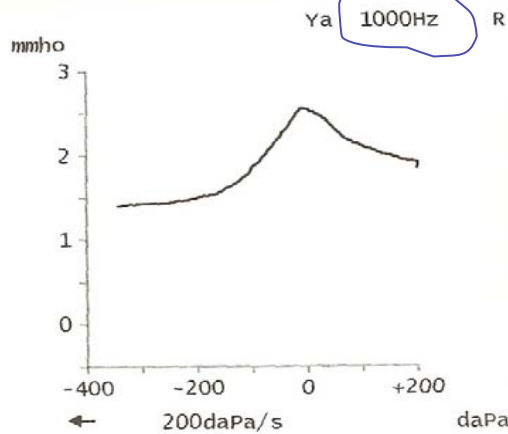
What ??s Still Need to be Answered?

- How do I interpret the “other” tymps?
- Can I use the norms interchangeably?
- Do the norms apply to all pieces of equipment?
- Do we need norms for TPP?
- Other???

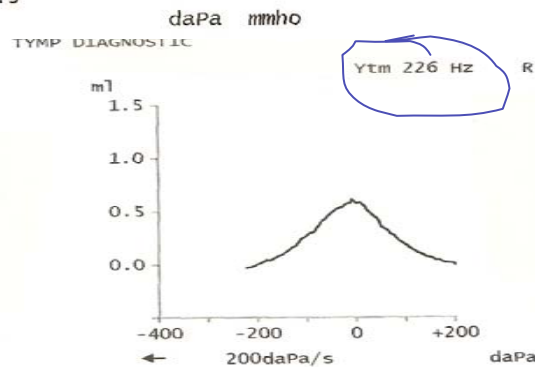


Case Studies: Normal tracings

TYMP DIAGNOSTIC



C1: 1.9

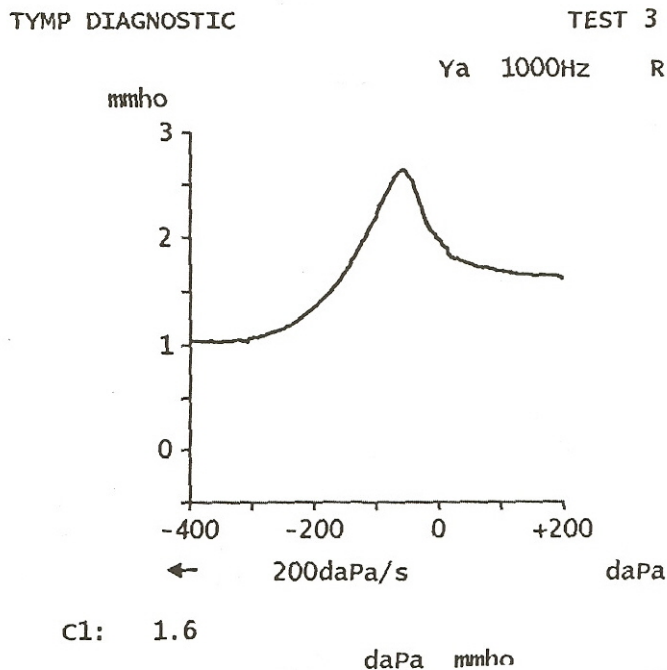


EARCANAL VOLUME: 0.5

TYMP 1: daPa m1
-10 0.6

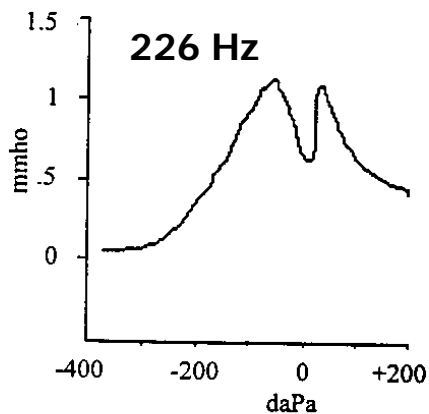
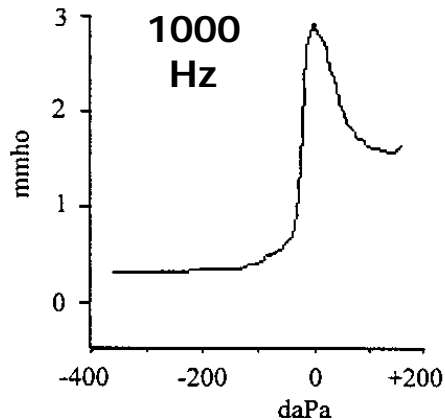
- 2 month old referred for rescreen
- Present/robust TEOAEs

Case Studies: Normal tracings



- 2 month old referred for diagnostic ABR
- Absent TEOAEs for the right ear
- Unilateral moderate-severe SNHL

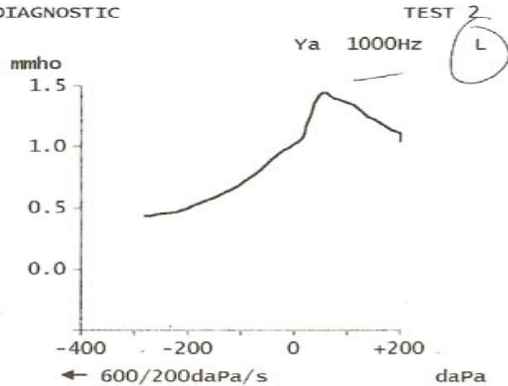
Case Studies: Normal tracings



- NICU baby
- Part of longitudinal study
- Stable with no complaints of MEE
- Why the "ski slope?"

Case Studies: Normal tracings

TYMP DIAGNOSTIC

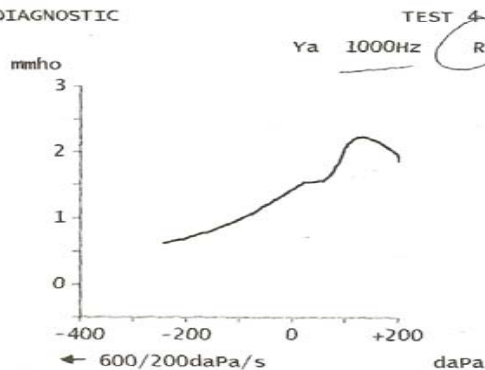


C1: 1.0

daPa mmho

TYMP 1:
TYMP 2:

TYMP DIAGNOSTIC



C1: 1.9

daPa mmho

TYMP 1:
TYMP 2:
TYMP 3:

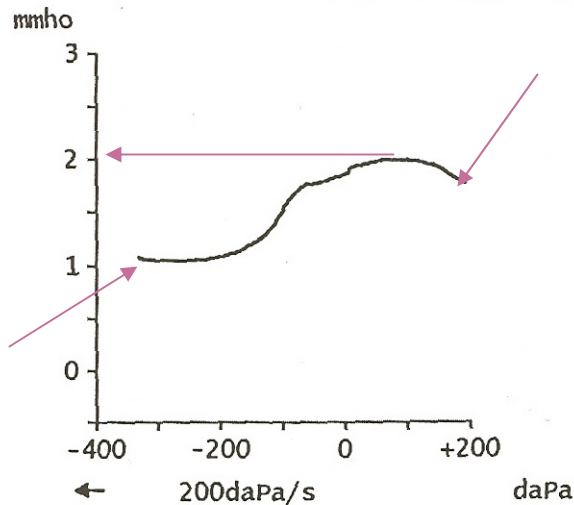
- 10 day old referred for rescreen follow-up
- Absent TEOAEs LE
- Present TEOAEs RE
- Results consistent with birth screening
- Referred for diagnostic ABR

Case Studies: "Other" tracings

TYMP DIAGNOSTIC

TEST 5

Ya 1000HZ R



c1: 1.8

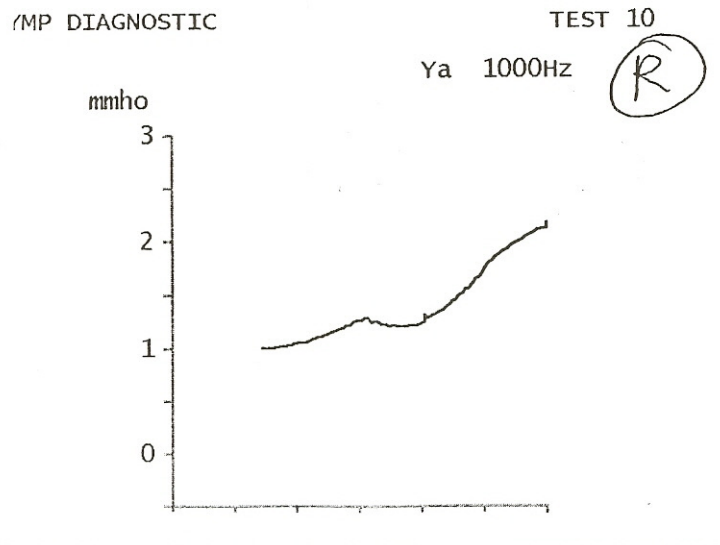
daPa mmho

TYMP 1:

TYMP 2:

- 2 month old referred for diagnostic ABR
- Present acoustic reflexes at 1000 & 2000 Hz (1000 Hz probe tone)
- ABR
 - Clicks down to 20 dBnHL
 - 500 Hz TB down to 25 dBnHL
- Present TEOAEs

Case Studies: Shallow/Other

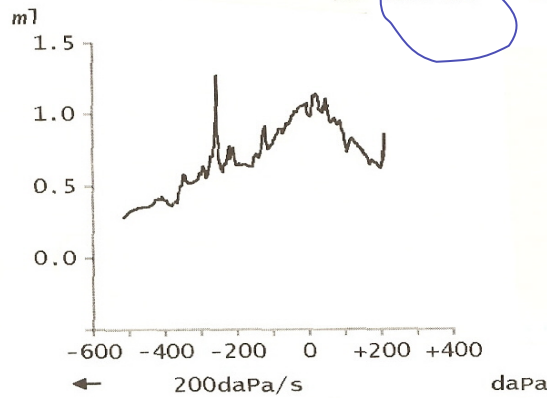


- 4 month old referred for diagnostic ABR
- ABR
 - TBs: 1k, 2k, 4k Hz down to 25-30 dB nHL
 - .5 k Hz down to 40 dB nHL
 - Child awoke prior to b/c assessment
- Absent TEOAEs
- Referred to ENT for MEE

Case Studies: Shallow/retraction

TYMP DIAGNOSTIC

TEST 12
Ya 226 Hz L



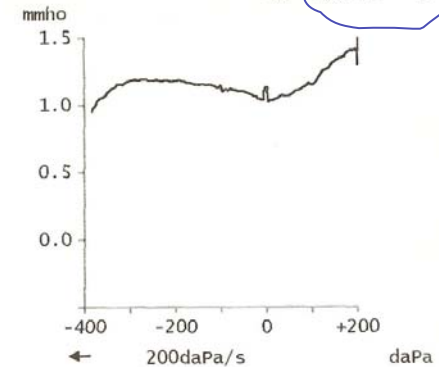
C1: 0.7

TYMP 1:

daPa 20
mL 1.1

TYMP DIAGNOSTIC

TEST 9
Ya 1000Hz L

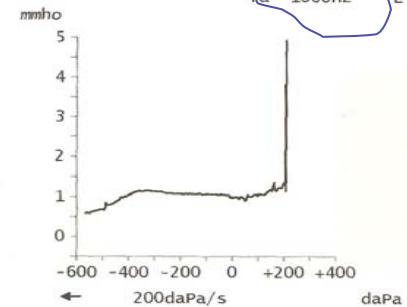


C1: 1.2

daPa mmho

TYMP DIAGNOSTIC

TEST 10
Ya 1000Hz L



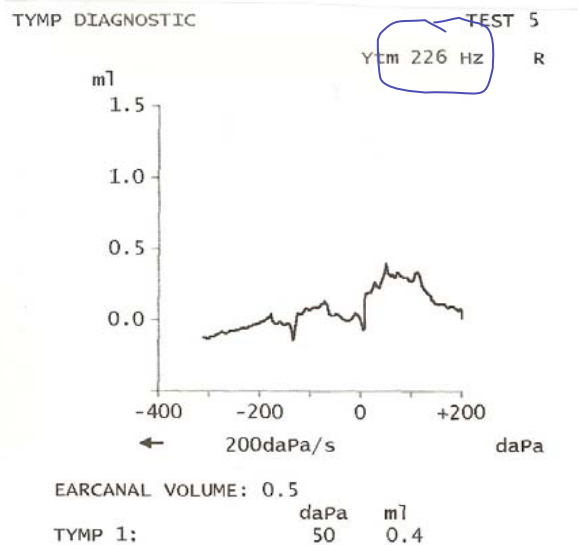
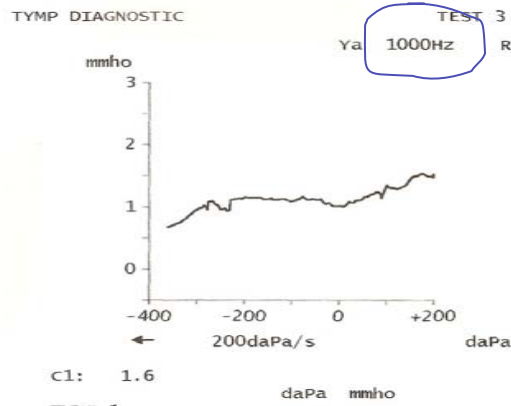
C1: 1.2

TYMP 1:

daPa mmho

- 2 month old referred for diagnostic ABR
- 15 dB difference between a/c and b/c click stimuli
 - Mild-to-moderate CHL
- Referred to ENT for MEE

Case Studies: Flat



- 3 mo referred for diagnostic ABR
- Absent ABR to click and TB stimuli
- Referred to ENT for medical work-up of profound SNHL with MEE overlay

Conclusions

- 1000 Hz tympanometry is effective and reliable in newborns – Normative data is available!
- Incorporate the procedure routinely for diagnostic assessments
- Correlate with other diagnostic measurements



Conclusions –

- Further study of this topic is needed
- More training on the appropriate use of tympanometry is needed
- 1000 Hz tympanometry normative data should be used consistently and correctly

