

Tympanometers

Chris Patricoski MD FAAFP

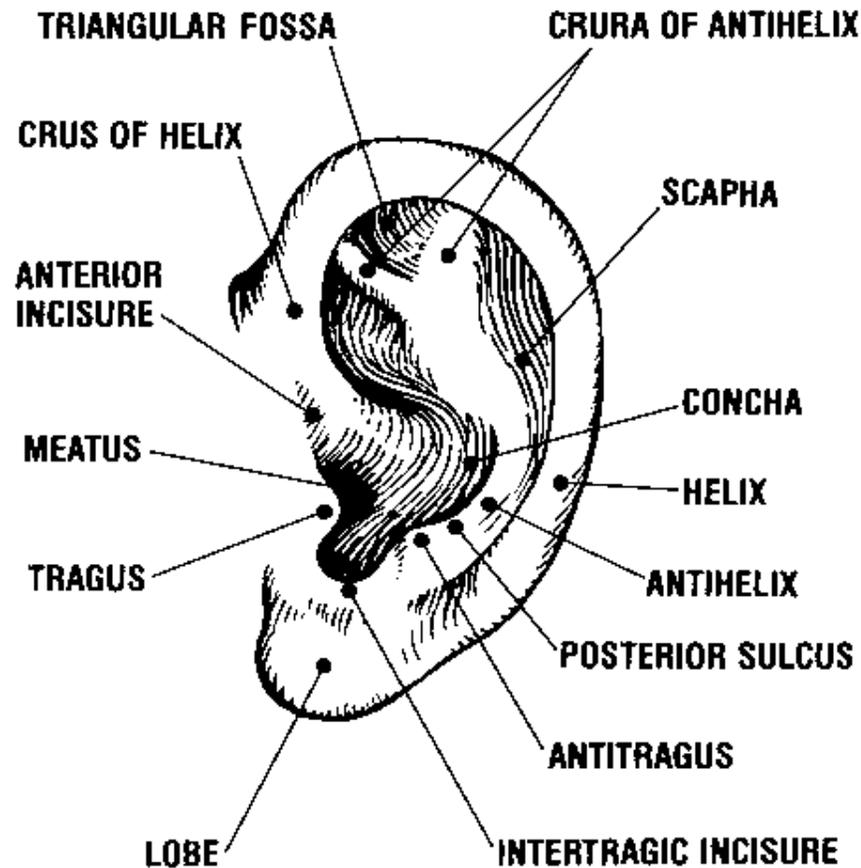
Telehealth Technology Assessment Center

ANTHC

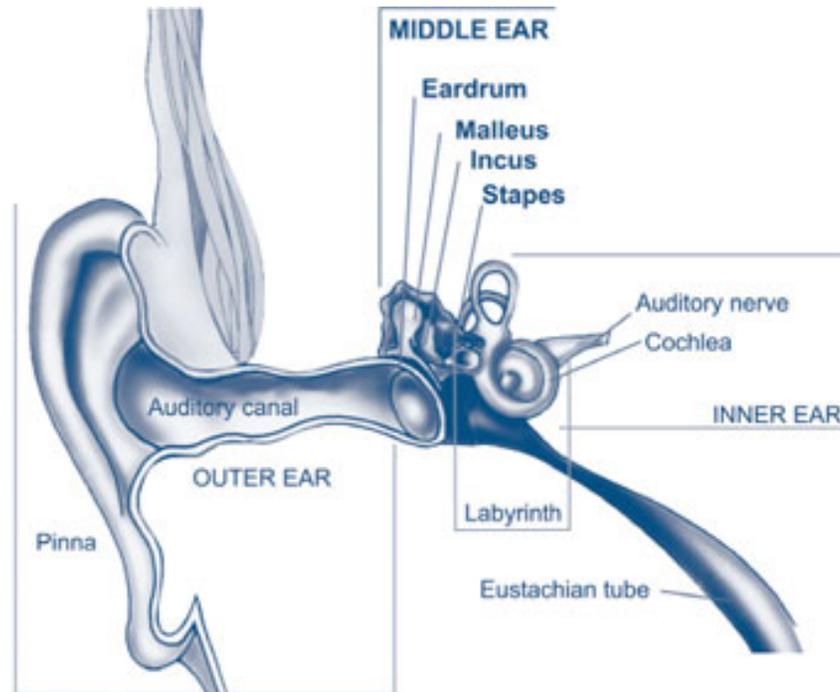
Anchorage, Alaska

May 24, 2012

External Anatomical Landmarks of the Ear



Anatomy of the Ear



Courtesy NIH Website
"Ear Infections in Children"
<http://www.nidcd.nih.gov/health/hearing/pages/earinfections.aspx>

Anatomy of the Ear

- External Ear
- Middle Ear
- Inner Ear
- Pinna
- Auditory Canal
- Tympanic Membrane

Ossicular Chain

- Malleus
- Incus
- Spapes

Stapedial Muscle

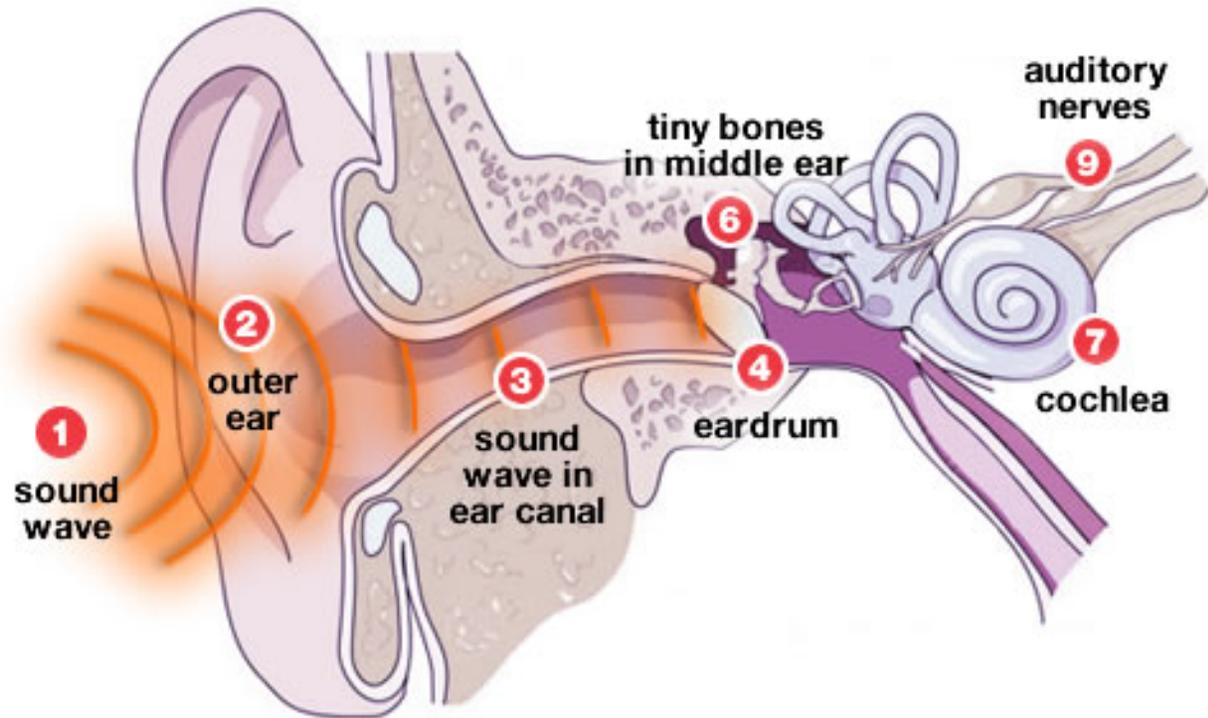
Oval Window

Cochlea

Hearing

- Sound energy stimulates the TM (eardrum) vibrating the ossicular chain. Vibratory motion of the stapes is transmitted through the oval window into the cochlea.
- Cochlea translates the sound energy into meaningful neuronal impulses to the brain.

Hearing and Anatomy

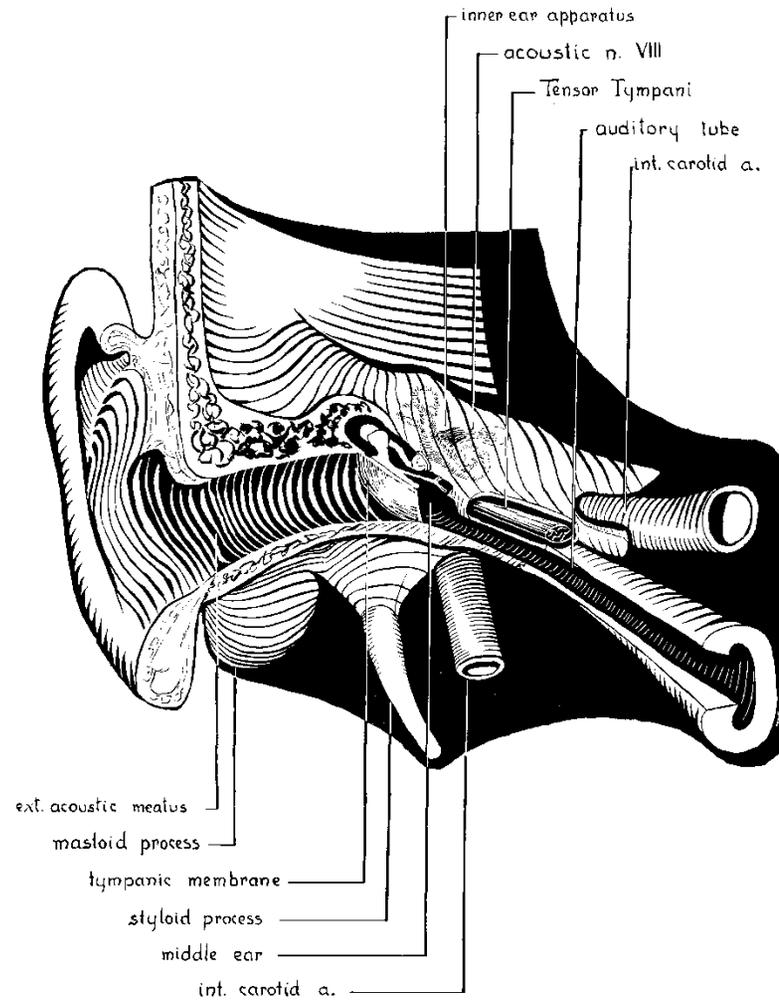


1. Something vibrates and creates a sound wave.
2. The sound wave travels to the ear and is collect by the outer ear.
3. The sound wave then moves into the ear canal.
4. When it reaches the end of the ear canal, the sound waves bump up against the eardrum.
5. The ear drum vibrates with these sound waves.
6. The vibration moves tiny bones in the middle ear.
7. These bones carry vibrations into the inner ear to a fluid-filled tube called the cochlea.
8. The fluid inside the cochlea vibrates a series of tiny hairs called cilia, which are attached to auditory nerves.
9. The movement of these cilia stimulates the nerve cells, and they send signals to the brain via auditory nerve.
10. The brain processes these signals into the sounds we hear

From Learning Ally. Benefits of Teaching Listening. How the Ear Hears.

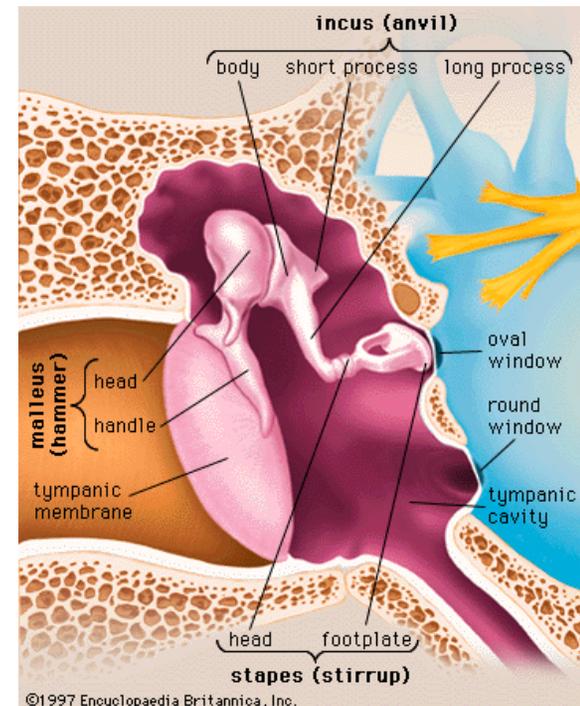
<http://www.learningally.org/Educators/Why-Teach-Listening/Benefits-of-Teaching-Listening/722>

Cranial Nerve VIII



Tympanometry - Definition

- Tympanometry measures the compliance of the TM and ossicular chain and estimates middle ear pressure.
- Compliance = Freedom of Movement (cc)



How it Works

Tympanometry utilizes two energy sources:

- Pressure
- Sound

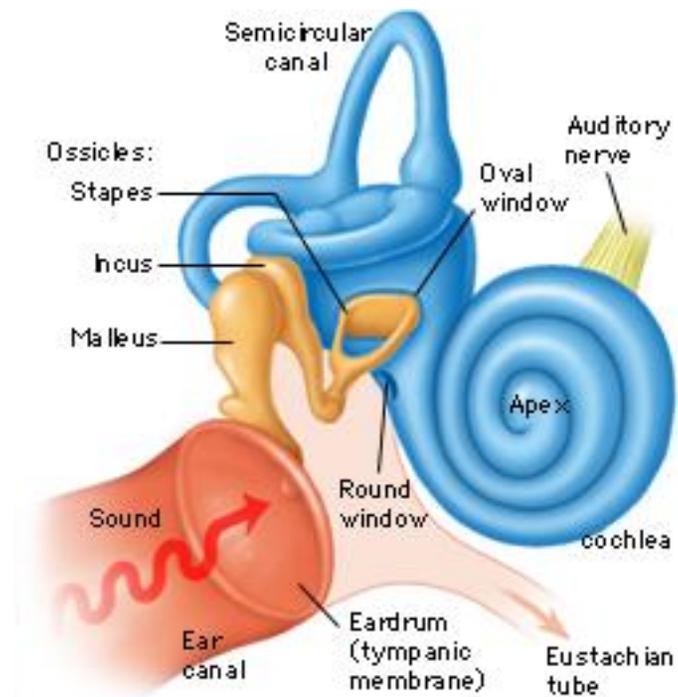


Units:

1. Pressure = daPa (deca Pascals)
2. Sound = Hz (Frequency) dB (Loudness)
3. Compliance = cc

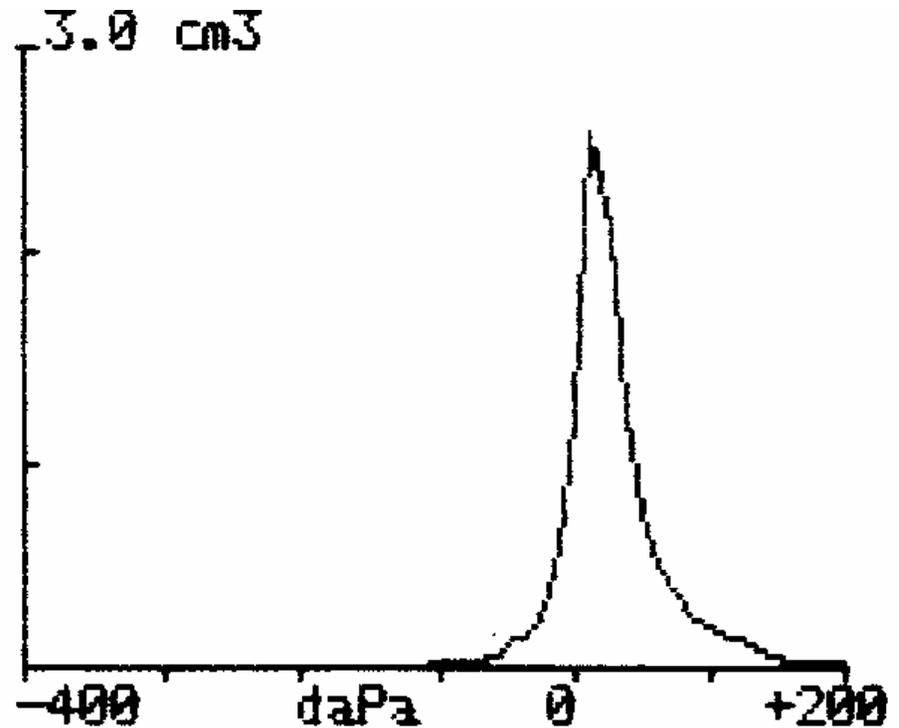
How it Works

- Pressure is introduced from +200 to – 300
- Sound is constant at 226 Hz and 85 dB
- Compliance is measured in terms of volume (cc)



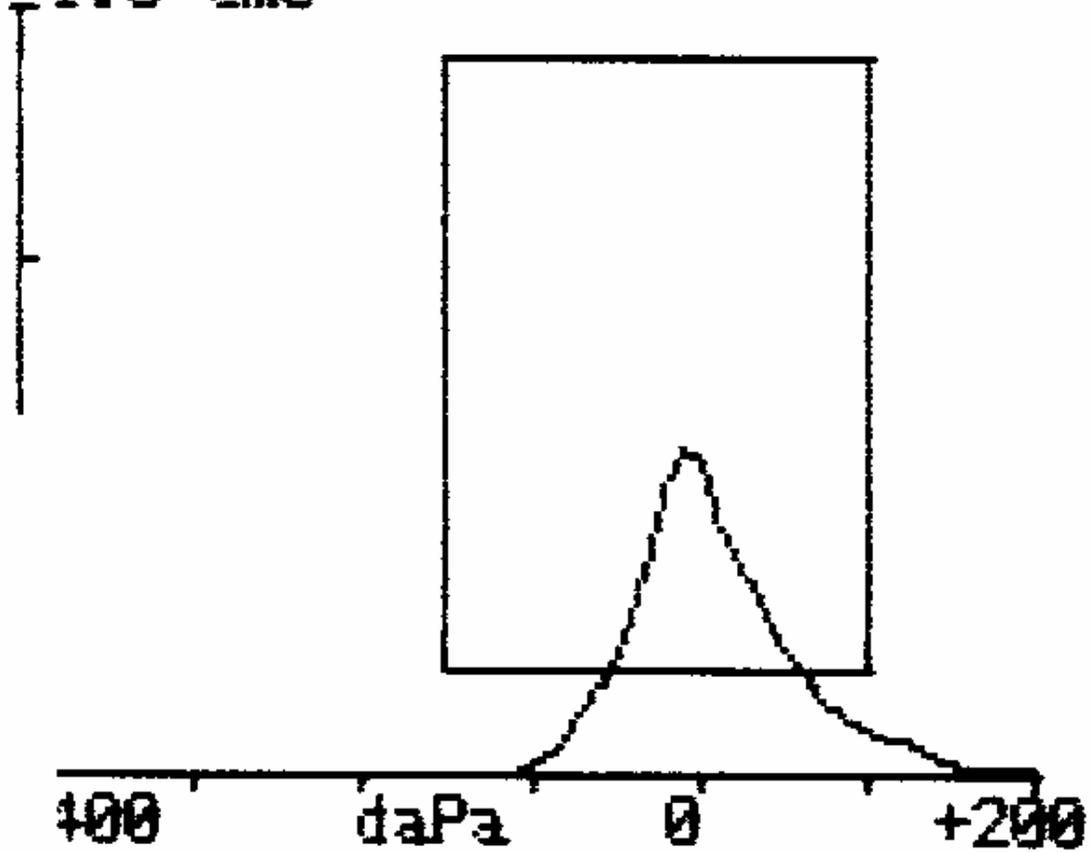
How it Works

- Pressure changes on the x-axis (horizontal)
- Compliance changes on the y-axis (vertical)

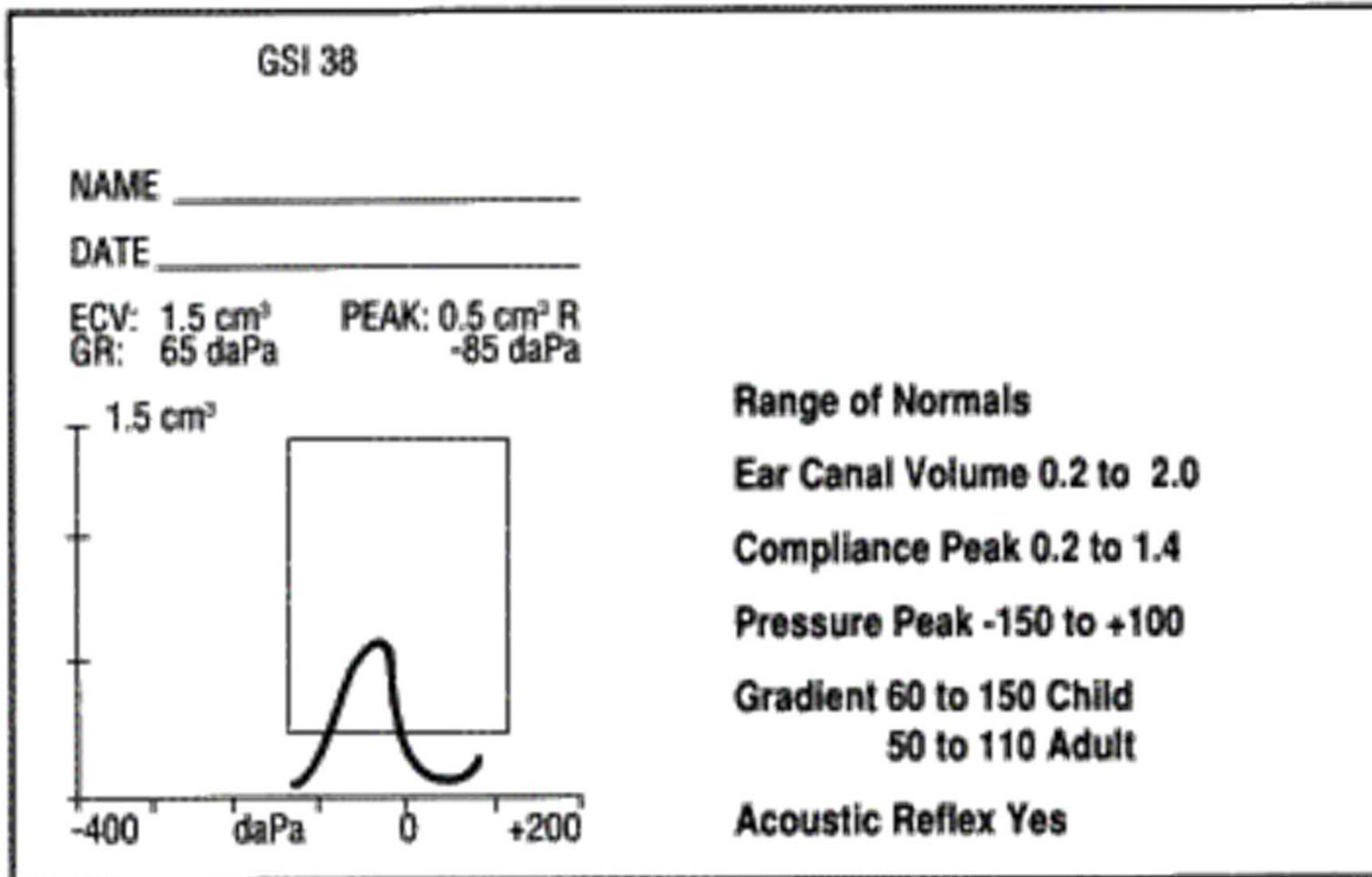


Values

ECU 1.7 cm³ PEAK 0.7 cm³ L
GR 79 daPa - 10 daPa
1.5 cm³



Values



Tympanometry - Steps

- Calibrate
- Place ear cuff on tip
- Select appropriate buttons
- Insert probe; obtain proper seal
- Read feedback from machine
- Remove probe
- Label tympanogram as Left or Right
- Save or print tympanograms

Diagnosis of Acute Otitis Media (AOM)

Clinical Practice Guidelines from American Academy of Pediatrics and American Academy of Family Physicians Subcommittee on Management of Acute Otitis Media. Diagnosis & management of acute otitis media. Pediatrics 2004 May;113(5):1451-65.

Diagnosis of AOM requires:

- History of acute onset of signs and symptoms
- Presence of MEE (middle ear effusion)
 - Bulging of the tympanic membrane
 - Limited or absent mobility of the tympanic membrane
 - Air-fluid level behind the tympanic membrane
 - Otorrhea
- Signs or symptoms of middle ear inflammation
 - Distinct erythema of the tympanic membrane
 - Distinct otalgia (discomfort clearly referable to the ears that results in interference with or precludes normal activity or sleep)

- The AAP/AAFP/AHRQ guidelines for AOM require the documentation of **middle ear effusion** for the diagnosis of AOM by **tympanometry, pneumatic otoscopy**, acoustic reflectometry, tympanocentesis, or the visualization of fluid in the external ear canal with tympanic membrane perforation. However, for OME and AOM, pneumatic otoscopy is recommended as the primary tool for diagnosis of middle ear effusion.

American Academy of Pediatrics Subcommittee on Management of Acute Otitis Media. Diagnosis and management of acute otitis media. *Pediatrics* 2004;113:1451–65

Pneumatic Otoscopy and Tympanometry

The two tests are complementary...

- Pneumatic otoscopy provides a qualitative measure of tympanic membrane mobility (i.e., does the TM move with insufflation?)
- Tympanometry produces more quantitative information (e.g., numeric and graphic data about generated positive and negative pressures, absorption of acoustic energy by the middle ear system, ear canal volume).

Onusko E Tympanometry Am Fam Physician 2004;70:1713–20.

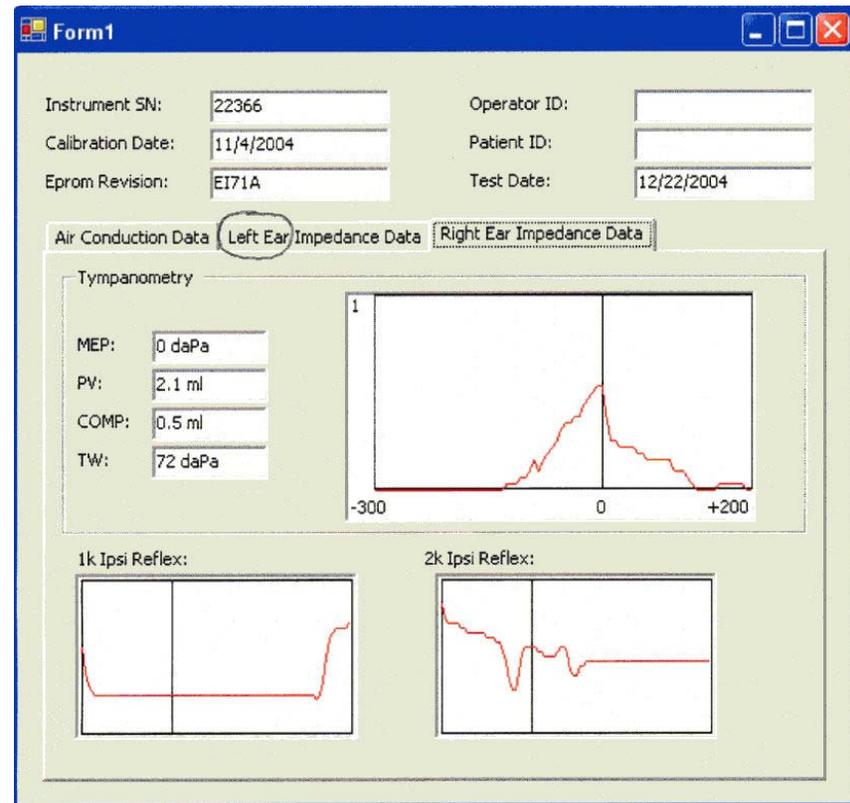
Kaleida PH, Fireman P. Diagnostic assessment of otitis media. Clin Allergy Immunol 2000;15:247–62.

Managing otitis media with effusion in young children. Pediatrics 1994;94:766–73

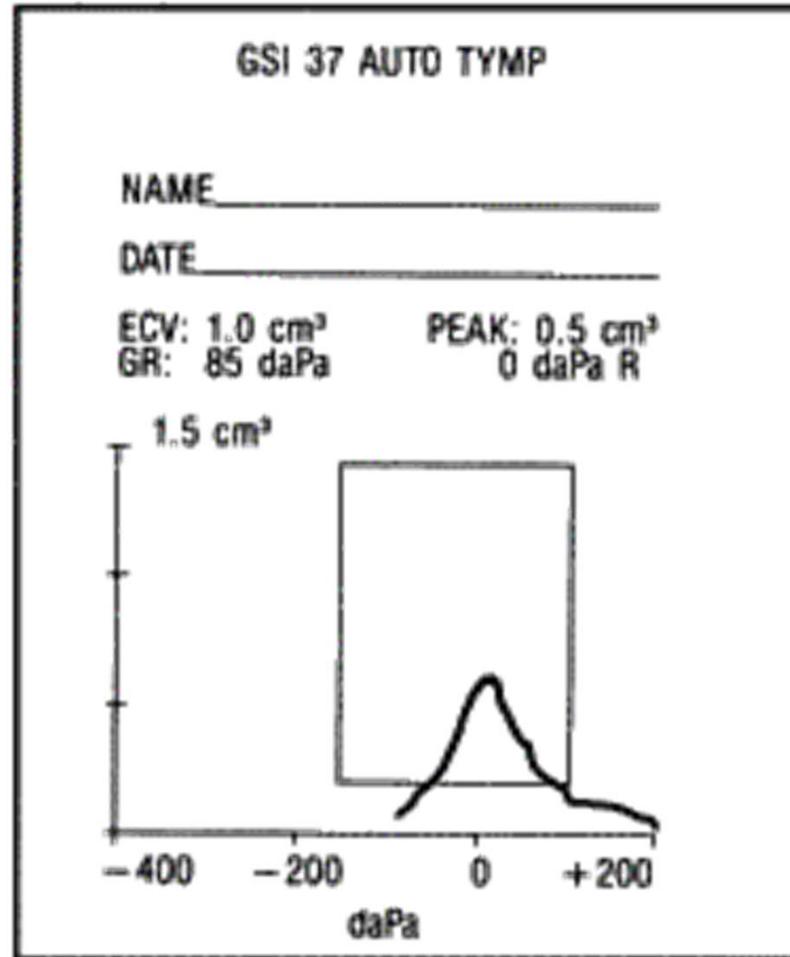
Clinical Indications

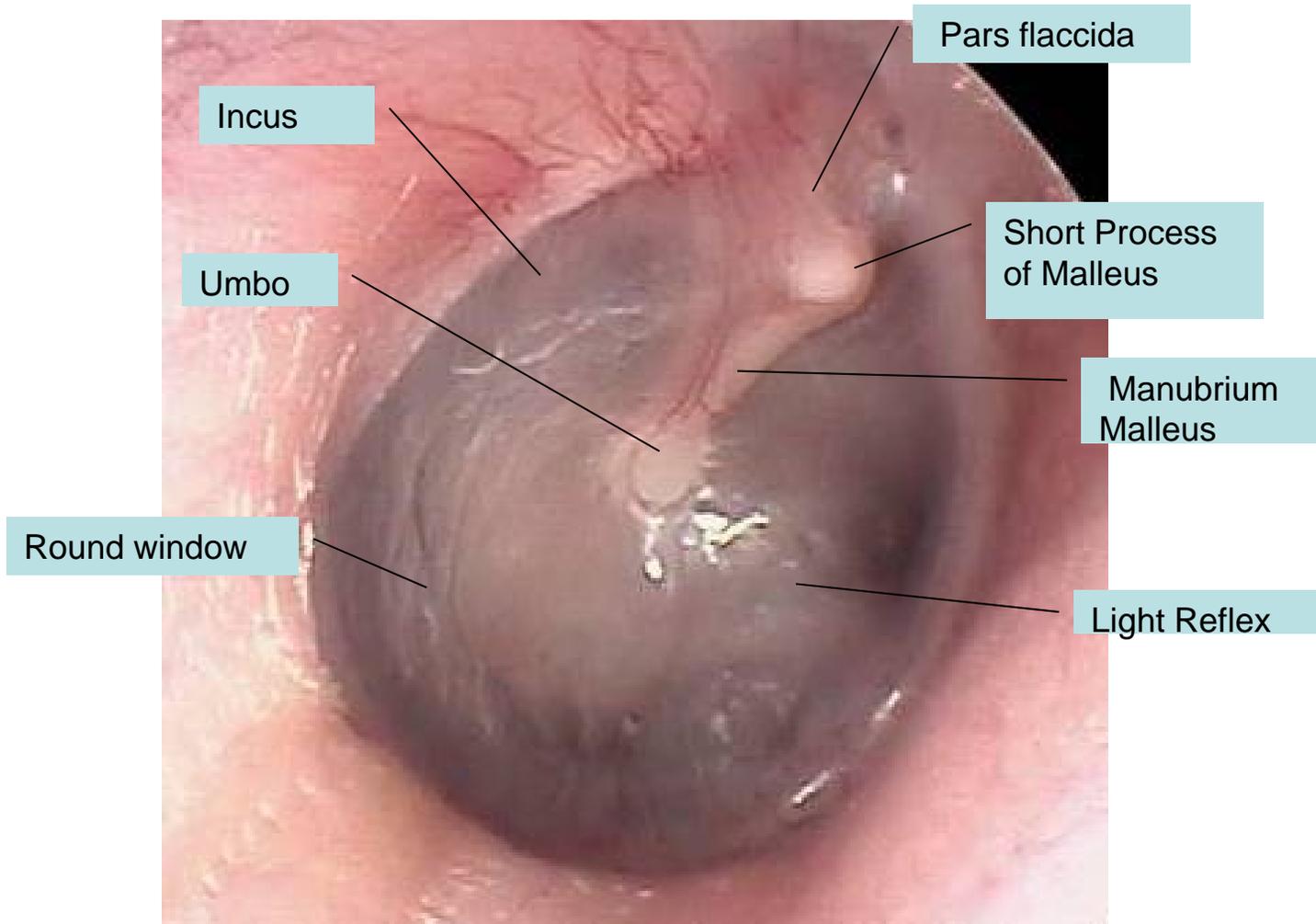
- Nonspecific ear complaints
- Hearing Loss
- Ear pain without observed problems
- Subtle TM changes
- Middle ear effusion; Serous Otitis
- Resolved Otitis Media
- Ear Tubes

Normal Ear

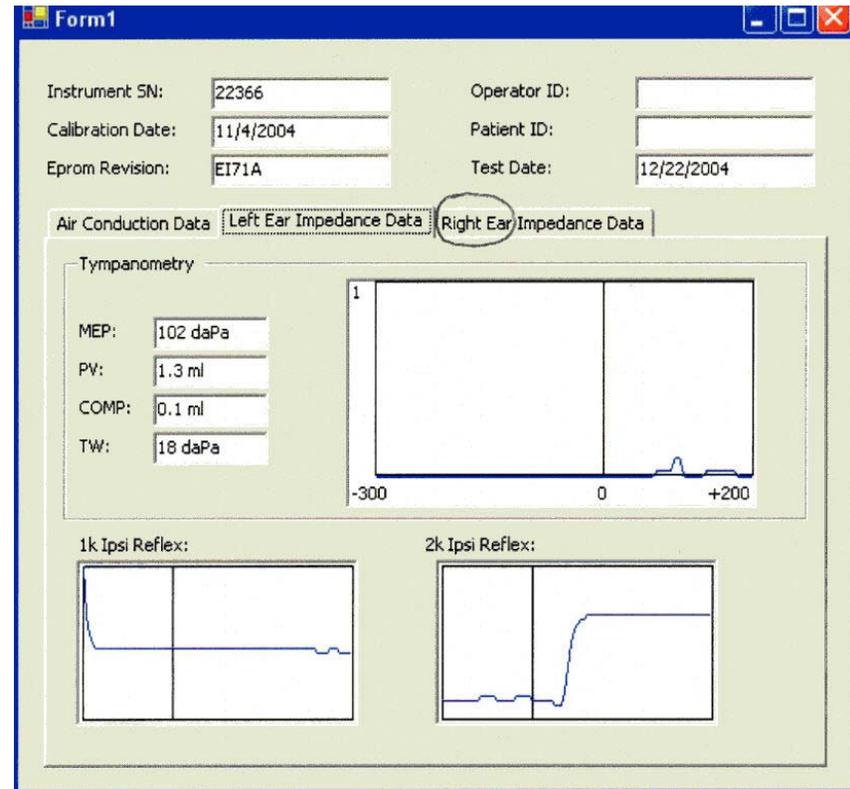
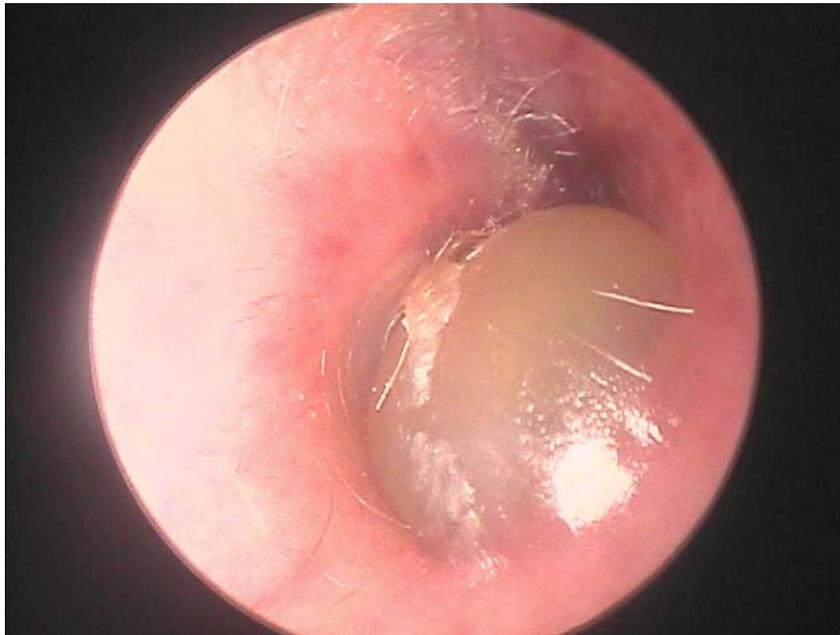


Normal

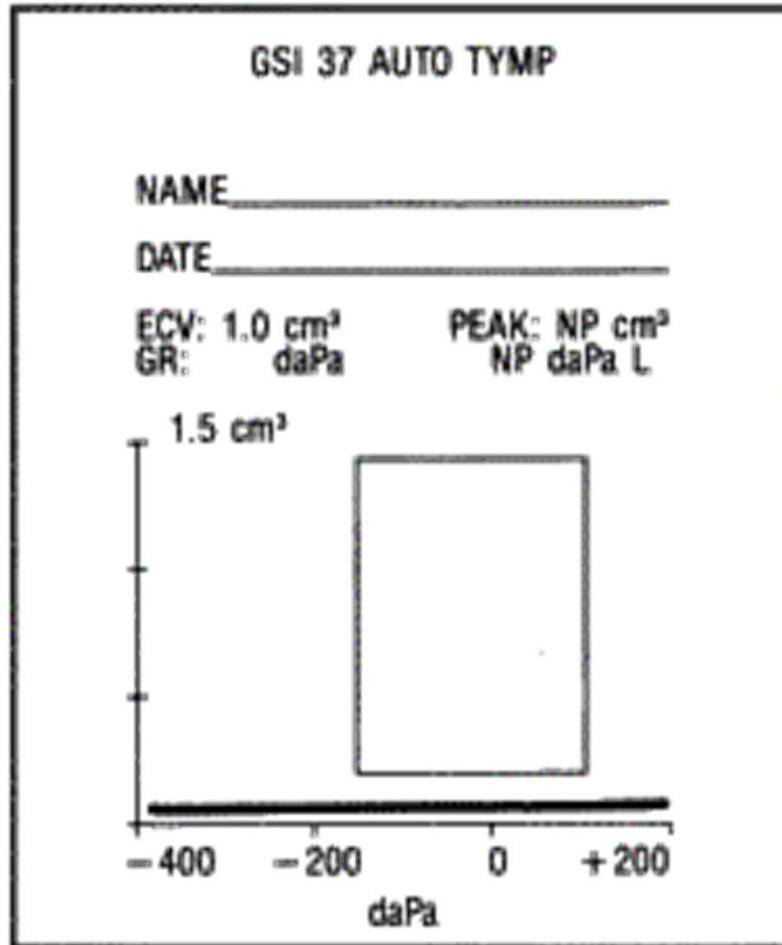




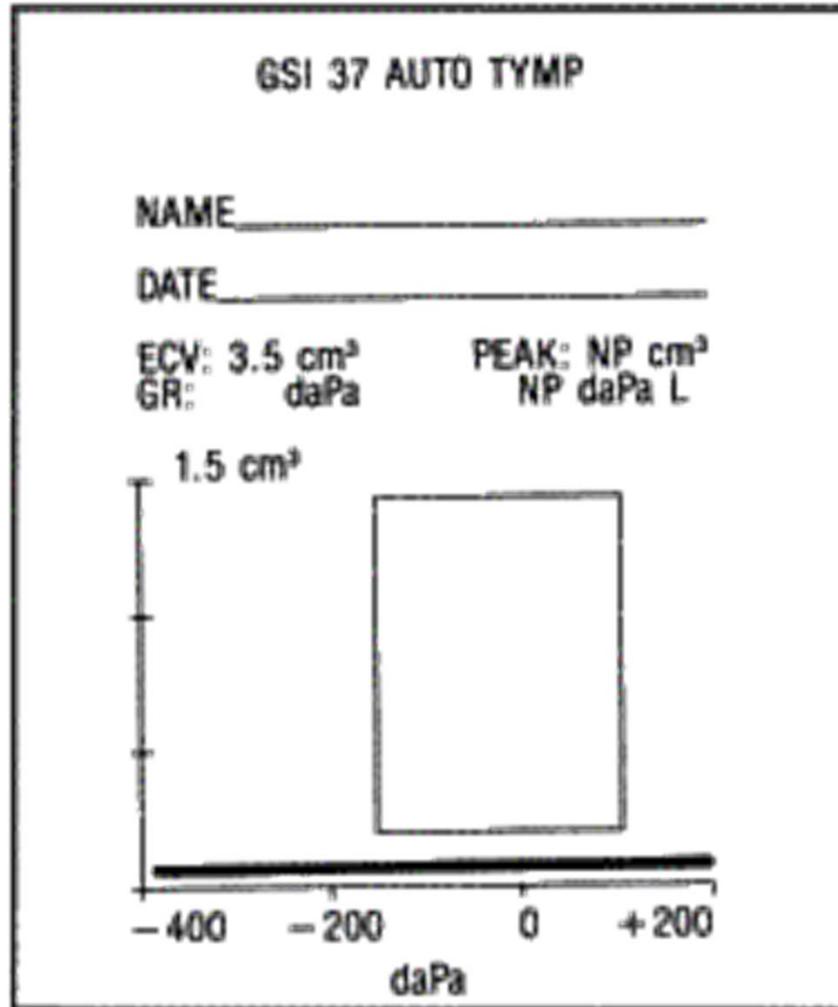
Otitis Media



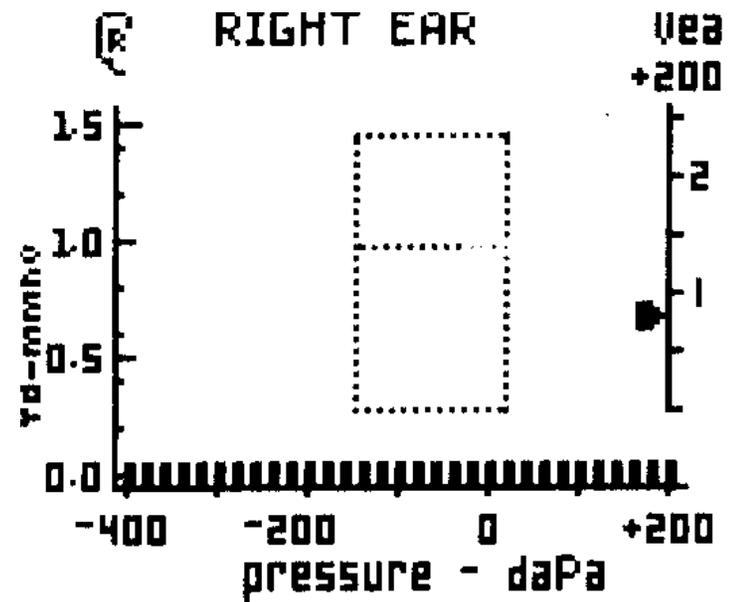
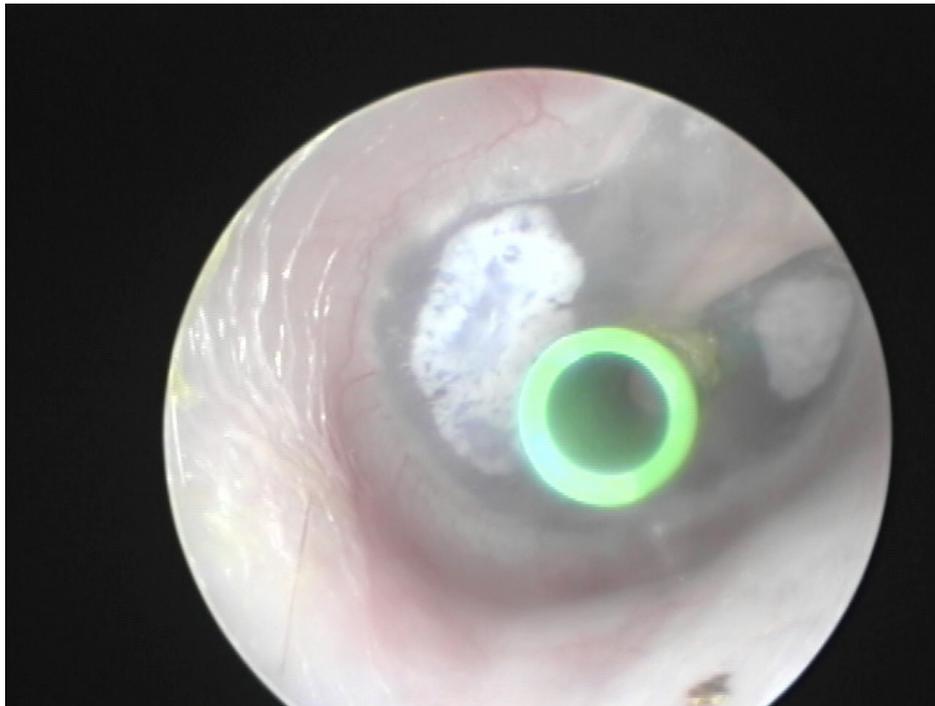
Flat TM: Serous Otitis



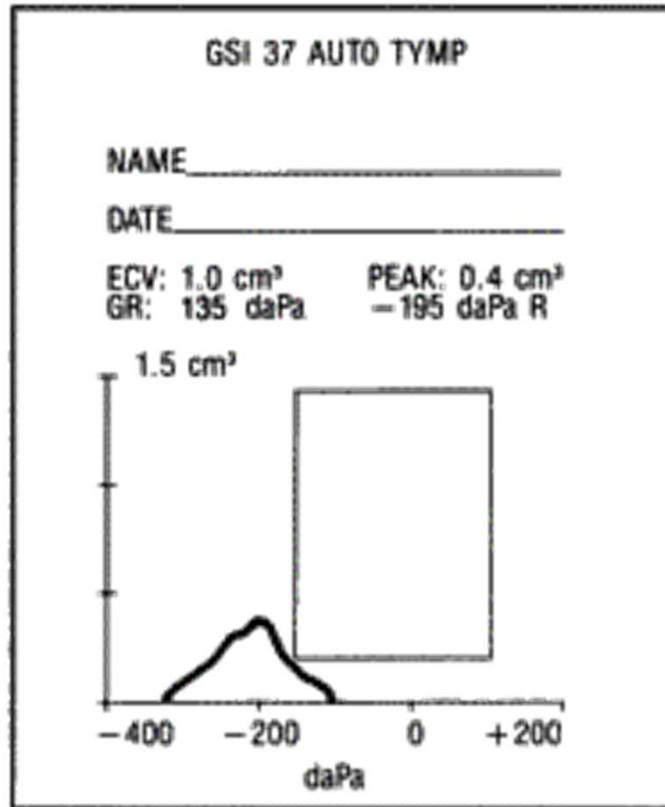
Flat TM: Patent Tube

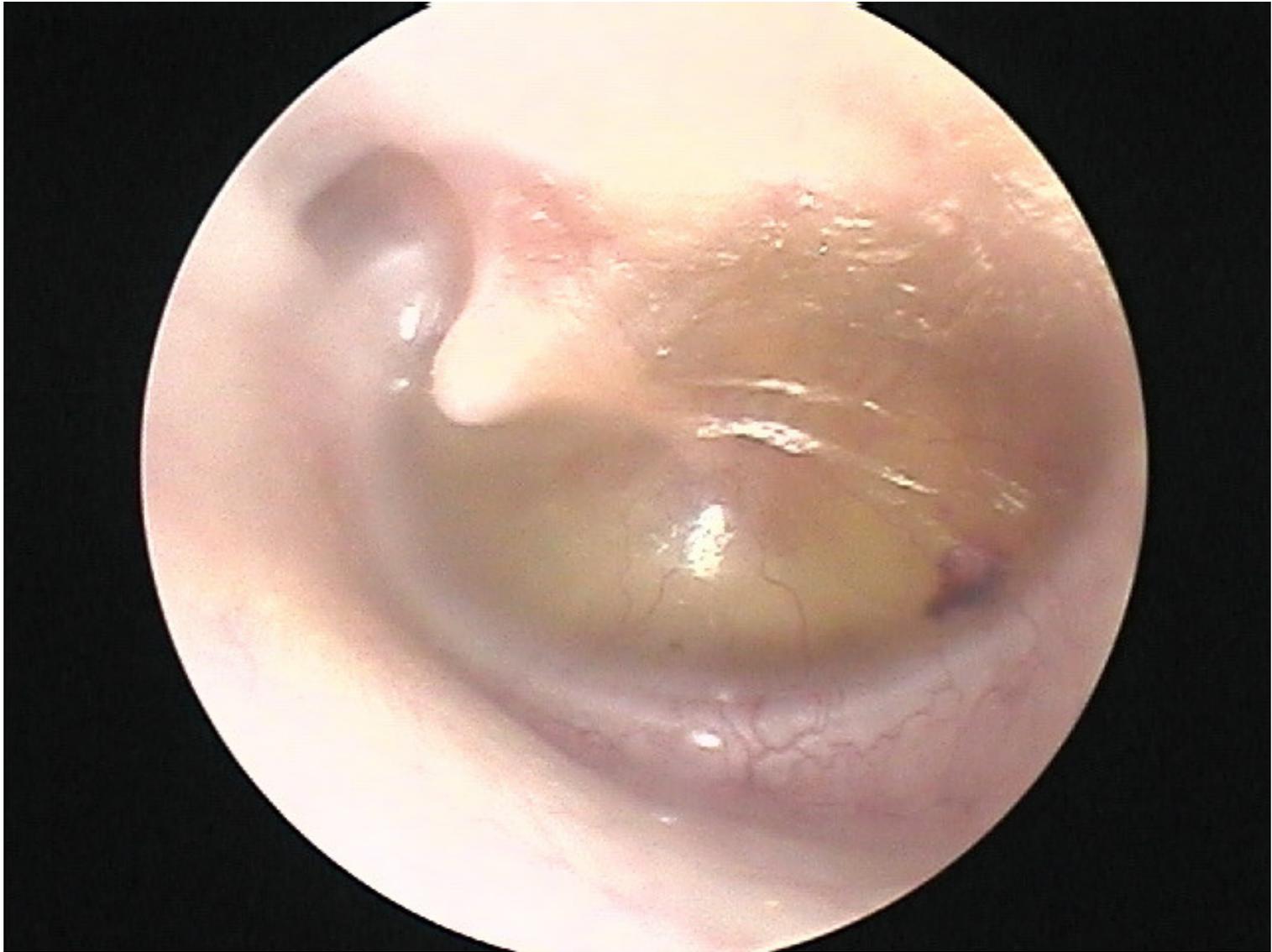


Tympanostomy Tube - Functional

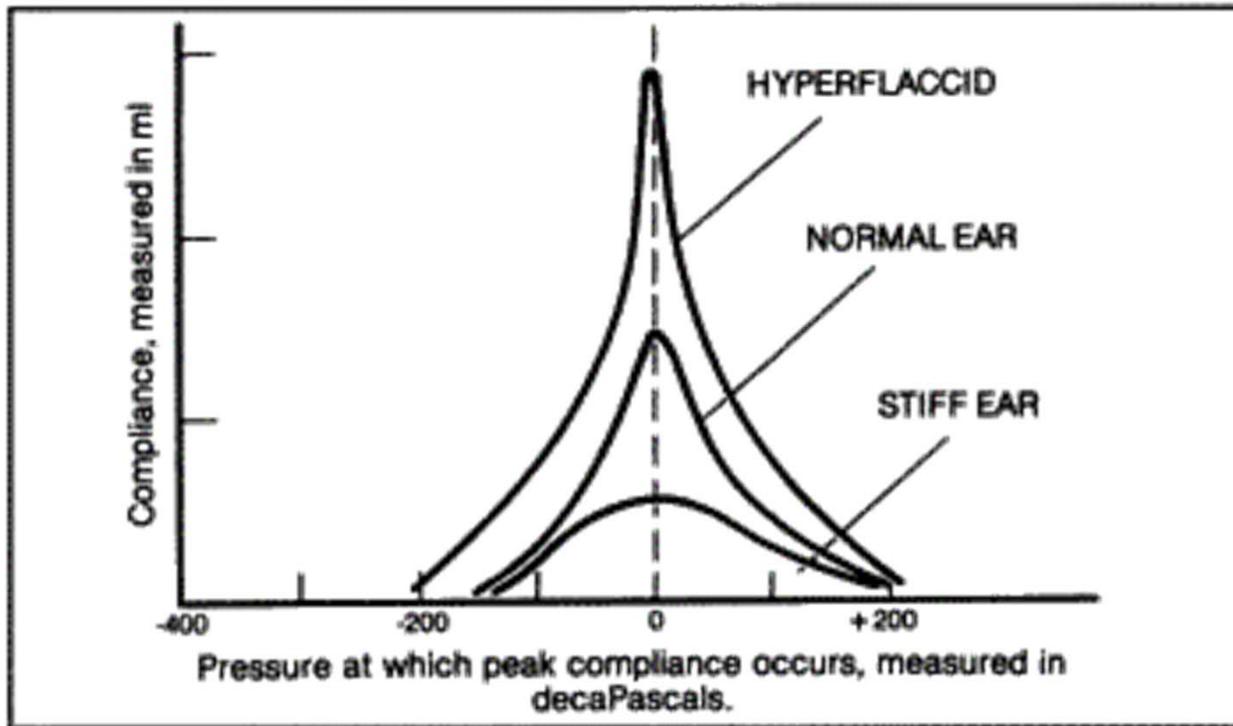


Abnormal: Negative Pressure

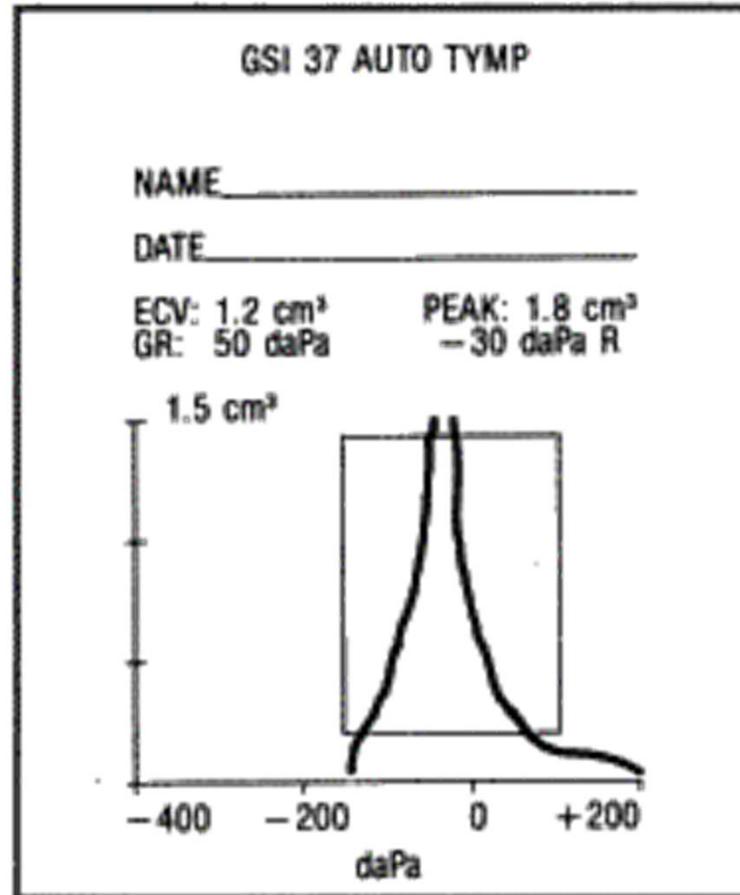




Compliance of the TM & Ossicles

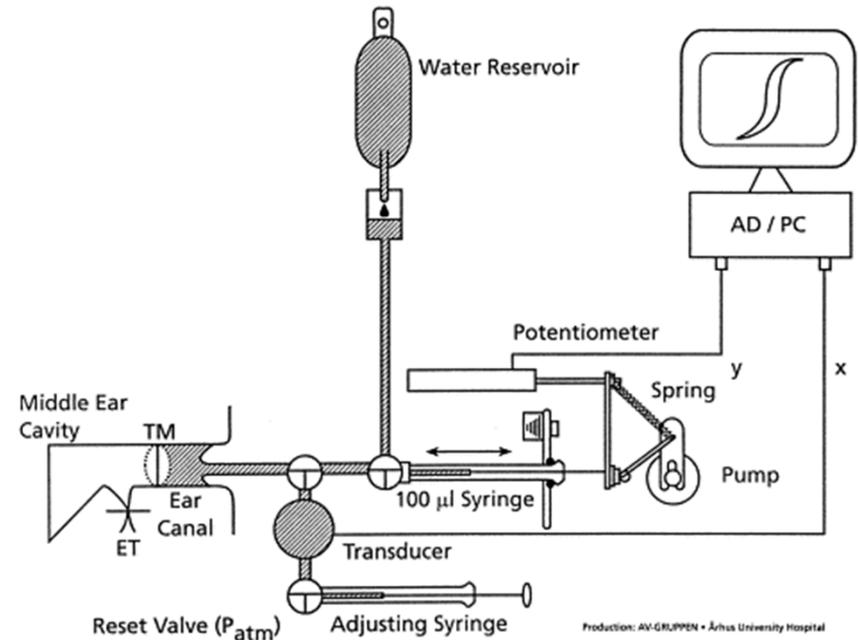


Abnormal: Hyperflaccid TM



Possible Future Developments

- A new method measuring the pressure–volume relationship of the middle ear system (MES) that express the dynamic mechanical properties of the MES.
- Compared with tympanometry the method is more detailed and has several advantages, which are discussed, and it has been found valuable for future mechanical studies of the MES



Gailhede M. Mechanics of the middle ear system: computerized measurements of its pressure–volume relationship. [Auris Nasus LarynxVolume \(1994\) 26, Issue 4](#), Pages 383–399

GSI 39 Auto Tymp (Grason Stadler)



EasyTymp (MAICO)



MT10 (Interacoustics)



MicroTymp 3 (Welch Allyn)



Handheld Unit

GSI 39 Auto Tym



EasyTym



MT 10



MicroTym 3



Connector pins of MT 10

MT 10



MT 10



Connections

GSI 39 Auto Typ

EasyTymp



MT 10



MicroTymp 3



Data Transfer

GSI 39

- Test results may be transferred to an external computer for data storage via the second built in USB port. This data is made NOAH compatible.

Easy Tymp

- The handheld unit enables the transfer of data to a PC via USB-connection. The unit is compatible with NOAH 3 software.

Data Transfer

MT 10

- Data may be transferred to the Interacoustics database program OtoAccess™ for Windows® and printed together with other patient data. Data transfer to NOAH is also possible.

MicroTymp 3

- Has an infrared data transfer to docking station and station can connect via port for data transfer. Micro-USB port at the bottom of the handheld unit can be used for transfer of data to computer via WA software.

Integration into telemedicine software

AFHCAN Telemedicine

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ATS ATSCient 4.2
El Servero Working On-Line
0 Cases in Transit
[Privacy Statement](#)
[Terms of Use](#)

Tympanometer

Patient: El Servero-B-122
Case #: El Servero-B-122
User: DefaultUser, AdminUser

Date: 3/15/2005 Time: 15:11:31 Label: LEFT 15:11:31

Tympanogram - Normal Speed

	Young Child	Adult
Pressure (of middle ear):	-100 - +100	-100 - +100
Gradient (pressure width):	60 - 150	50 - 110
Compliance (of TM):	0.2 - 1.5	0.2 - 1.5
Volume (of ear canal):	0.4 - 0.8	1.0 - 2.5

Pressure (of middle ear): 6 daPa
Gradient (pressure width): 84 daPa
Compliance (of TM): 0.8 ml
Volume (of ear canal): 1.4 ml

Acoustic Reflex Test - Ipsilateral

Tone presented at 1000 Hz and 105 dB

Tone presented at 2000 Hz and 105 dB

Instrument Serial Number: 22321 EPROM Revision: EX71A Calibration Date: 3/5/2005

LABEL LEFT 15:11:31 Ear: Left Right

Log Out Save Back

AFHCAN tConsult Software & Earscan Tympanometer

The Probe Tip – Ear Seal is Most Important



Earscan Probe and Tip
(Microaudiometrics)

Probe

GSI 39 Auto Tymp



EasyTymp



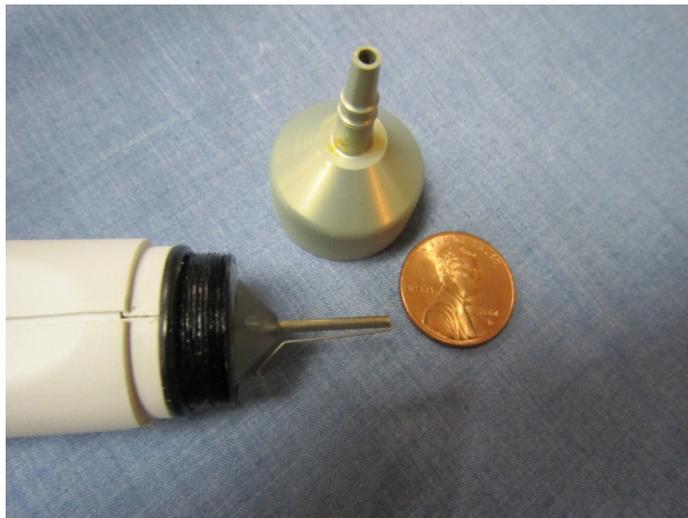
MT 10



MicroTymp 3



GSI 39 Auto Tym



Probe

EasyTym



MT 10



MicroTym 3



Probe with Tip

GSI 39 Auto Tympanometer



MT 10



EasyTymper

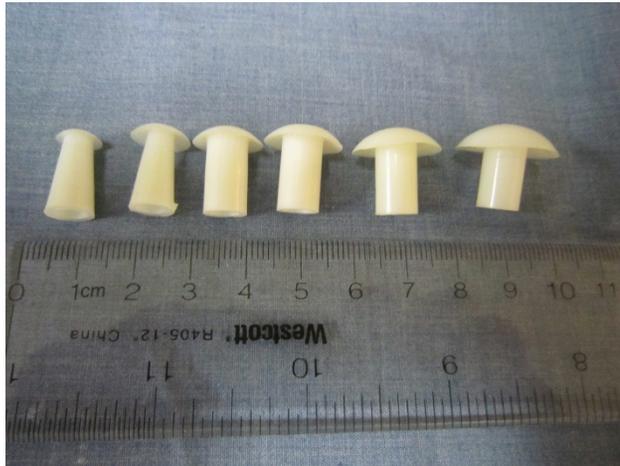


MicroTymper 3



Ear Tips

GSI 39 Auto Tym



EasyTym



MT 10



MicroTym 3



Probe tip in ear and the view.

GSI 39 Auto Tympanometer



EasyTympanometer



MT 10

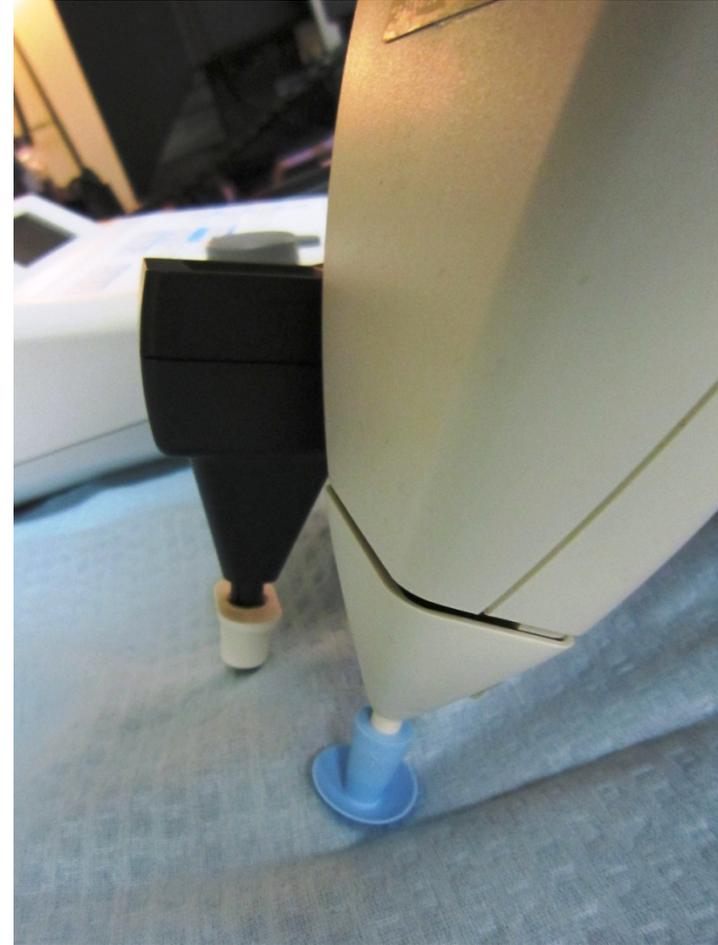


MicroTympanometer 3



Note it is difficult to visualize the tip-ear seal.

Probe angle and head piece



View of tip from user perspective.



Overall Ease of Use

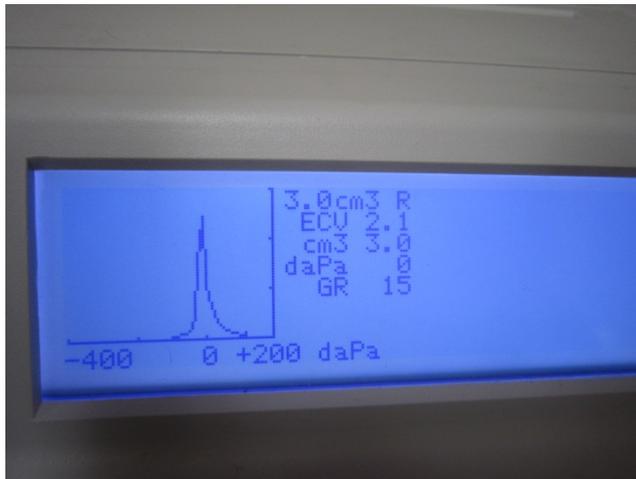
	GSI 39	Easy Tymp	MT 10	Micro Tymp 3
This device is intuitive.	4	4	4	4
Easy to use on adult.	5	4	4	4
Easy to use on a child	5	4	4	3
Comfortable & Non-invasive	5	4	4	4
Simple to obtain a good seal of the tip	5	4	4	3

Based on this reviewer's evaluation/opinion using a Likert scale of 1 to 5 where...

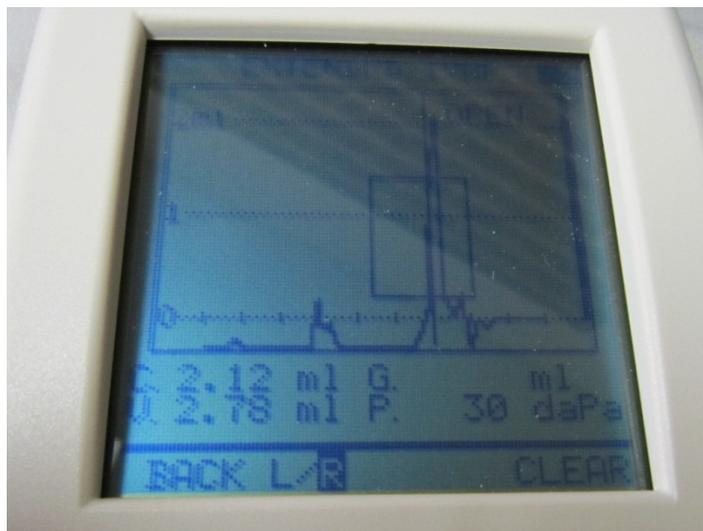
5 is Very Good,
4 is Good,
3 is O.K.,
2 is Poor and
1 is Very Poor

Screen

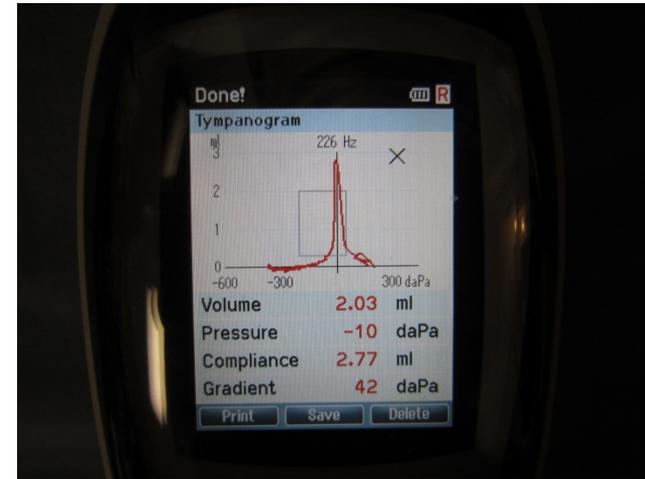
GSI 39 Auto Tymp



MT 10



EasyTymp



MicroTymp 3



LCD Screen - Monitor

	GSI 39	Easy Tymp	MT 10	Micro Tymp 3
Size	4	3	5	2
Brightness	4	5	3	3
Glare Free	4	3	3	3
Color	3	5	3	3
Resolution	4	5	4	3
Text Clarity	4	4	5	3
Viewing Angle	90 deg	120 deg	60 deg	90 deg

Based on this reviewer's evaluation/opinion using a Likert scale of 1 to 5 where...

5 is Very Good,
4 is Good,
3 is O.K.,
2 is Poor and
1 is Very Poor

Screen Information Layout

	GSI 39	Easy Tymp	MT 10	MicroTymp 3
Graph Resolution	4	5	4	2
Graph Axis & Normals	4	4	4	4
L/R Designation	4	4	4	3
Compliance & Pressure Values Visible	5	5	5	3
Status: Open, Blocked, Leak	4	4	4	5

Based on this reviewer's evaluation/opinion using a Likert scale of 1 to 5 where...

5 is Very Good,
4 is Good,
3 is O.K.,
2 is Poor and
1 is Very Poor

Power Cord

GSI 39 Auto Tympanometer



EasyTym



MT 10



MicroTym 3



Power Cord and Transformer Brick

GSI 39 Auto Typmp



EasyTypmp



MT 10



MicroTypmp 3



Changing Battery

GSI 39 Auto Tymp

EasyTymp



MT 10

MicroTymp 3



Batteries

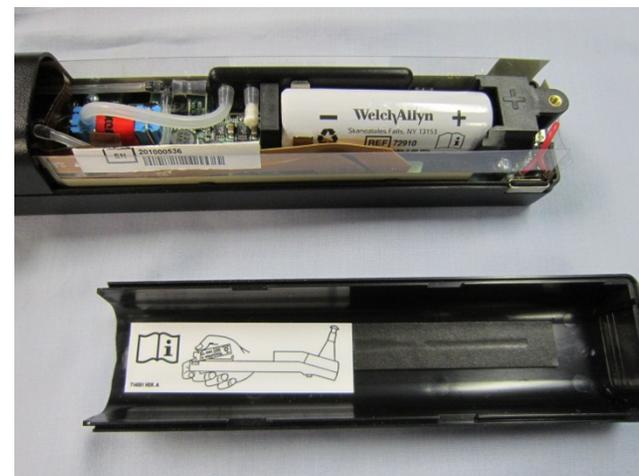
GSI 39 Auto Tympanometer

EasyTympanometer



MT 10

MicroTympanometer 3



Print

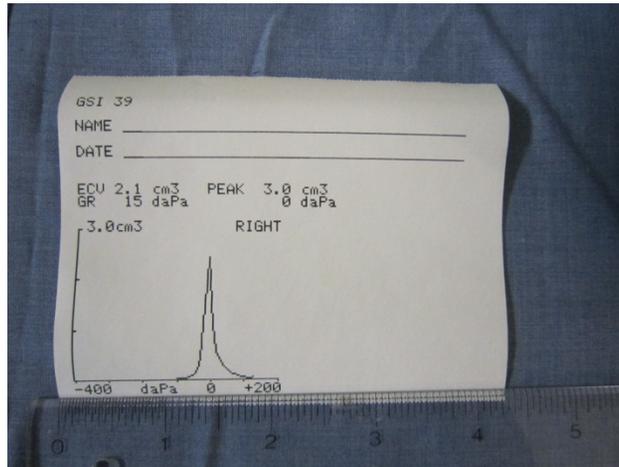
	GSI 39	Easy Tymp	MT 10	MicroTymp 3
Printing Indicator	4	4	4	4
Data Layout of Print	5	5	5	5
Print Quality	4	4	4	4
Speed of Printer	5 sec	6 sec	15 sec	4.5

Based on this reviewer's evaluation/opinion using a Likert scale of 1 to 5 where...

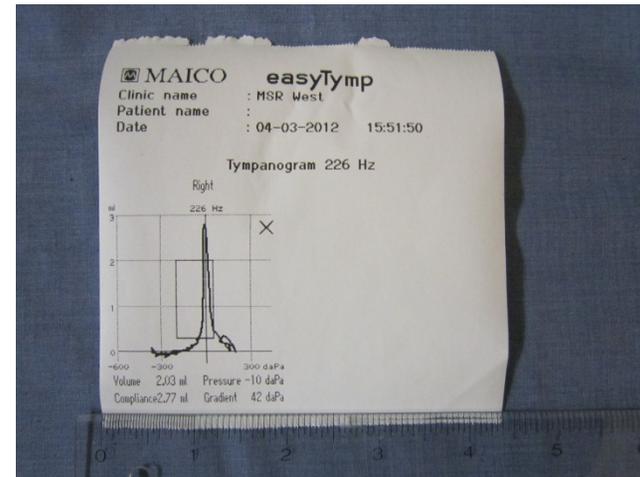
5 is Very Good,
4 is Good,
3 is O.K.,
2 is Poor and
1 is Very Poor

Print Outs

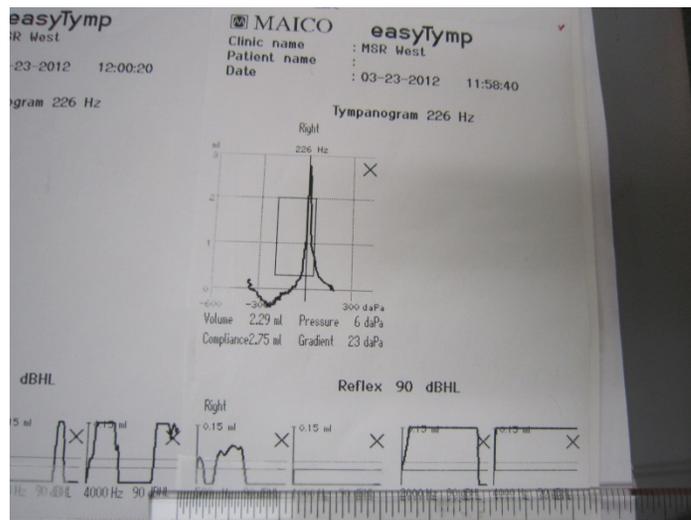
GSI 39 Auto Tym



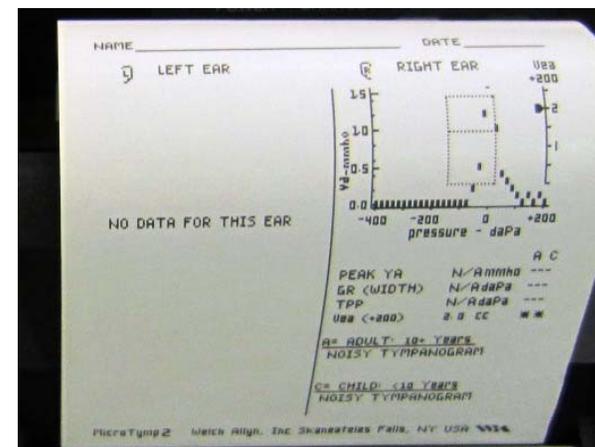
EasyTymp



MT 10



MicroTymp 3



In Summary

Four good choices for Tympanometers

- Form Factors... Pros and Cons
- Ease-of-Use... Pluses and Minuses
- Data Transfer... compatible, additional cost
- Will see more integration into EHRs and telemedicine software in the future