The fitting of hearing aids with in-situ measurements
fitting in situ of hearing aids

definition

why to acquire them

advantages

how to acquire them
REM • definition

- Real Ear Measurement
- **objective and repeatable** method for quantifying the intensity of a stimulus in the patient’s ear canal
REM • why to acquire them

• to obtain the best configuration of the HA depending on patient’s needs

• to avoid setting device’s gains based on average population curves → prediction error
REM • why to acquire them

comparison between five proprietary programming algorithms and the NAL-NL2 formula

the Speech Intelligibility Index is always higher in the case of NAL-NL2

REM • advantages

- visual demonstration of the benefits provided by the device
- patient satisfaction
- significant reduction in the number of repeated medical examinations

Inventis • Audiology Equipment
REM • how to acquire them
what it does
valid, repeatable and reliable method for assessing the value of the sound in dB SPL to 3mm - 5 mm from the tympanic membrane

aim
• to check the hearing aid performance, while it is worn by the patient
• to ensure that the sounds from the hearing aid output are audible and comfortable
how are they performed?

• speaker

• probe microphone placed at 3mm – 5mm from the eardrum

• reference microphone placed at the base of the pinna

• hearing aid
  
  not inserted (UNAIDED)
  
  inserted and turned off (OCCLUDED)
  
  inserted and turned on (AIDED)
REM • how to acquire them

free field speaker

probe mic

reference mic
measuring quantities at stake:

- how much does the patient’s ear canal amplify, naturally, **without the hearing aid**?

- how much does the insertion of a hearing aid **occlude** the patient’s ear canal, reducing the natural amplification?

- how much does the hearing aid **amplify** sounds, after being inserted and switched on?
algorithms aimed at determining a target amplification curve that represents the ideal listening level for the user of the HA
REM • fitting rules

NAL
National Acoustic Laboratories

DSL
Desired Sensation Level
preliminary tests • Otoscopy

- verify the presence of **earwax and exudate**
- provide detailed information on the **anatomy of the ear canal**
- exclude the presence of **problematic situations**
**preliminary tests • Pure Tone Audiometry**

Earing threshold is the **only mandatory input** needed to calculate the target curve.

Audiometry **starting point for estimating optimal gains** to generate a certain sound intensity at the eardrum.
REM • preliminary procedures
REM • preliminary procedures

- **SPEAKER EQUALIZATION**
  
  **AIM:** sound that reaches patient’s ear is the same emitted by the loudspeaker

- **PROBE TUBE CALIBRATION**
  
  **AIM:** make the microphone and probe tubes “acoustically invisible”

- **PROBE TUBE PLACEMENT**
RE - real ear measures acquired on the patient

A, I, O, U symbolize the hearing aid state

R and G don’t provide info on the hearing aid state

**RESPONSE:** value at probe

**GAIN:** difference between the value at probe and reference
Maestro software exam allows to perform the following test modalities:

- **Standard** acquisition mode (unaided, occluded, aided)
- **MPO** (Maximum Power Output)
- **Advanced** mode
- **Live Speech** mode (Speech Mapping)
HA not inserted (UNAIDED)

**REUG**: real-ear unaided **gain**
- difference between dB SPL measured at the probe mic and dB SPL measured at the reference mic. Ear canal **not** occluded
- each software provides a predicted average REUG, e.g. kemar (→ estimate)

**REUR**: real-ear unaided **response**
dB SPL measured at the probe; ear canal **not** occluded
HA inserted and turned off (OCCLUDED)

**REOG**: real-ear occluded gain
- difference between dB SPL measured at the probe mic and dB SPL measured at the reference mic, ear canal occluded, frequently negative
- useful to evaluate the effectiveness of any vents in the ear mold, applied to allow certain frequencies to enter the canal

**REOR**: real-ear occluded response
dB SPL measured at the probe; ear canal occluded
REM • Aided Measurements

HA inserted and turned on (AIDED)

**REAG**: real-ear aided gain
- difference between dB SPL measured at the probe and dB SPL measured at the reference
- it considers the amplification provided by the hearing aid and the ear canal
- it is used to get closer to the calculated target

**REAR**: real-ear aided response
dB SPL measured at the probe
HA Inserted and turned on (AIDED)

**REIG**: real-ear insertion gain

- difference between dB SPL measured at the probe and dB SPL measured at the reference
- it considers only the amplification provided by the hearing aid, without any contributions of the ear canal

\[
REIG = REAG - REUG
\]
users of occluded HA often complain of a **lack of naturalness in the perception and amplification of their own voice**

**Open Fitting**

- allows almost *complete communication* between the air outside and inside the ear canal
- for patients suffering *high-frequency hearing loss* (poor amplification at low frequencies)
- **ATTENTION**: *acoustic feedback*
HA Inserted and turned on (AIDED)

MPO
maximum power output
response measurement to check that the output (MPO) of the hearing aid does not exceed the UCL identified for the patient, even when a signal of high intensity is generated (typically 85 dB SPL)
HA Inserted and turned on (AIDED)

LIVE SPEECH

- live monitoring of input and output signal, aimed to focus on the real advantages of the hearing aid amplification (counseling)

- comparison between the response measured with the hearing aid inserted and active, with the estimated response without hearing aid

- opportunity to use the doctor’s voice or a relative’s voice as a signal
REM • ON TOP mode

selecting it during an AIDED, MPO or LIVESPEECH measurement, the window of the program is reduced in size, and the operator can use a hearing aid setting application, while keeping the Maestro interface on the screen.
complete audiometer with FF speaker and REM system in a small carrying case!

size: 40 x 25 x 16 cm
weight: approx. 2.5 Kg
TRUMPET

only one hardware, but 3 modules

- Trumpet REM
  system for in-situ measurements

- Trumpet AUD
  diagnostic audiometer

- Trumpet REM +AUD
TRUMPET-REM

built-in speaker

extremely small and light probes

probe mic
d-hole for flexible support
reference mic

graduated scale
TRUMPET-REM

Inventis • Audiology Equipment
TRUMPET ON YOUTUBE
Thank you for your attention