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PICO Question:

In adults with SNHL, do patients prefer programming of their hearing aids by measured LDLs or prescribed LDLs assessed by subjective validation measures?

Resources Searched:



Data Bases Searched:	Keyword Search Terms:	Number of Hits:
Google – October 27, 2008	Loudness discomfort level	30,100
Pubmed – October 27, 2008	Loudness discomfort level	63
Pubmed – October 27, 2008	Uncomfortable loudness levels	40
Pubmed – October 27, 2008	Prescribed loudness discomfort levels	4
Pubmed – October 2, 2008	Measured loudness discomfort levels	17
USF library Metasearch – November 5, 2008	Subjective and prescribed loudness and hearing	11
USF library Metasearch – November 5, 2008	Loudness discomfort levels	55
USF library Metasearch – November 5, 2008	Uncomfortable loudness levels	48

I also used the reference section of the two articles I selected.

Search Strategies:



• *Inclusion Criteria:*

- Population: Adults with SNHL
- Intervention: Measured loudness discomfort levels
- Comparison: Prescribed loudness discomfort levels
- Outcome: Subjective measures (APHAB etc)

• *Exclusion Criteria:*

- Study involving pediatric populations
- Studies with conductive hearing losses
- Studies with normal hearing

Articles Selected:



- *2 articles remained after applying the inclusion and exclusion criteria.*
- Mackersie, C. L. (2007). Hearing aid maximum output and loudness discomfort: Are unaided loudness measures needed? *J Am Acad Audiol*, 18, 504-514.
- Preminger, J. E., Neuman, A. C., & Cunningham, D. R. (2001). The selection and validation of output sound pressure level in multichannel hearing aids. *Ear & Hearing*, 22, 487-500.

Description:



- Two studies were found involving adults with SNHL with hearing aids that were programmed with either measured or prescribed LDLs.
- Level of Evidence: III

First Author and Year of Publication	Location	Comparison	Number of patients	Outcomes
Mackersie, 2007	USA	Prescribed and measured LDLs	28	APHAB, Munro Patel loudness questionnaire, Profile of aided loudness
Preminger, 2001	USA	Prescribed and measured LDLs	20	Subjective measures of speech quality (5 pt scale) and clarity (11 pt scale)

Background:

6

- Setting the max. output too high results in problems with aided loudness discomfort levels
- Agreement that max. output should be below LDLs when fitting hearing aids, but there is no agreed upon method to do this
 - ✦ Measured or Prescribed
 - Prescriptive methods:
 - Storey et al (1998) found that for single channel hearing aids the max. output determined using NAL OSPL-90 prescription was in the acceptable range for 86% of the hearing aid users
- It is also important not to set max. output too low or else there may not be adequate headroom

Mackersie, 2007

7

- Retrospective study
- Participants:
 - 28 adults who got hearing aids in the last two years
 - Mean age of 74 years
 - Mean PTA of 44 dB HL
 - 22 were binaural HA users
 - 19 were experienced users
 - All wore multichannel hearing aids (2-15 channels)

Mackersie, 2007

8

- **HA fitting procedure:**
 - Initial settings based on NAL-NL1 targets for gain and max. output
 - Real ear measures were completed and adjustments to gain were made to make sounds comfortable
- **HA follow-up:**
 - Min. of 2 follow-up appointments before outcome evaluation
 - Adjustments made as needed
 - 13 participants had no gain or max. output adjustments

Mackersie, 2007

9

- Outcome measures scheduled at a min. of two months after fitting
- Loudness Growth Measures: Rating 1 (cannot hear) to 8 (LDL)
- Self-Report Loudness Questionnaires:
 - Abbreviated Profile of Hearing Aid Benefit (APHAB)
 - Munro-Patel loudness scale
 - 20 participants completed the Profile of Aided Loudness (PAL)
- Verification:
 - Used Fonix6500CX for low and average sounds using a digital speech-weighted signal and RESR measured using a 90 dB pure tone sweep
 - Participants reported if sounds were uncomfortable

Mackersie, 2007

10

- **Results:**
 - Prescriptive measures resulted in average RECD values of no more than 5 dB above measured LDLs for all but one participant
 - For largest RESR-LDL differences at any one freq., 93% had differences ± 10 dB
 - No reported discomfort during pure tone sweep during LDL measures
- **Hearing aid descriptions:**
 - 12 “basic” processing aids
 - ✦ <5 channels, omnidirectional, no digital noise reduction
 - 16 “advanced” processing aids
 - ✦ ≥ 5 channels and digital noise reduction, all but two had directional mics

Mackersie, 2007

11

- Results: Munro-Patel, APHAB, & PAL Questionnaires
 - No relationships between RESR-LDL differences and loudness questionnaire data
 - ✦ Could be attributed to hearing aid differences
 - Similar scores for basic and advanced hearing aids
 - Problems experienced by participants with RESR values that exceeded LDLs were similar to those whose RESR values were below the LDLs excluding the outlier

Mackersie, 2007

12

- **Results: Outlier Profile**
 - Single outlier with RESR-LDL difference exceeding 10 dB and APHAB score of 91
 - Despite recommendation to reduce the max. output the patient kept his hearing aid settings the same and was happy
- **Limitations of the study:**
 - Changes in loudness tolerance were not considered regarding the two year fitting time frame
 - Unclear whether changes made during the fittings would be similar to those made with measured LDLs

Mackersie, 2007

13

- **Conclusions:**
 - Results suggest the use of the NAL-NL1 approach for setting max. output for a multichannel hearing aid using aided output verification and loudness validation during the fitting
 - ✦ Cannot generalize to other prescriptive methods
 - No systematic relationships between the RESR-LDL differences and reported aided loudness problems

Preminger et al., 2001



- **Participants:**
 - 20 experienced hearing aid users with SNHL
 - Mean age of 62 years
 - 12 subjects were monaural hearing aid users
 - All fit with Oticon JUMP-1 digital research hearing aids
 - ✦ Two channels
 - ✦ Gain was programmed according to NAL-R
 - ✦ Real ear measures were used to verify fitting

Preminger et al., 2001



- **Methods:**
 - Prescribed OSPLs were calculated according to NAL OSPL method
 - LDLs were measured at .5, 1, 2, & 4 kHz
- **Validation Session I:**
 - Loud and avg. level speech signals were used to measure the acceptable OSPL range in the two channels of the hearing aid in quiet and in noise
- **Validation Session II:**
 - Subjects tested to see if range of OSPLs from session I resulted in clear speech and judged to be of good sound quality
 - ✦ Subjects rated clarity from 0 (extremely unclear) to 10 (extremely clear)
 - ✦ Speech quality rated from 0 (extremely poor) to 5 (very good)

Preminger et al., 2001



- Results:
 - Validation Session I:
 - ✦ Predicted OSPL was within the acceptable range 85% of the time for the low freq and 65% of time for high freq channel
 - ✦ Low freq. channel:
 - Predicted OSPLmax was below the measured OSPLmax
 - Except for four out of 40 cases
 - ✦ High freq. channel:
 - 5 of 20 would have felt the predicted OPSLmax was set too high
 - ✦ Adjusted OSPLmax was calculated using measured LDLs
 - 12 cases were too loud
 - Using measured rather than predicted LDLs did not improve the accuracy of the predicted OSPLmax
 - ✦ The correlation between the predicted and measured OSPL was significant in quiet but not in the noise condition

Preminger et al., 2001



- Results cont...
 - Validation Session II:
 - ✦ Using the range determined from Session I
 - ✦ Acceptable range for low freq. when measured
 - Lower boundary had a mean of -18.9 dB below predicted OSPL
 - Upper boundary had a mean of 8 dB above predicted OSPL
 - ✦ Acceptable range for high freq.
 - Lower boundary had a mean of -19.6 dB below predicted OSPL
 - Upper boundary had a mean of 7 dB above predicted OSPL

Preminger et al., 2001



- Results cont...
 - Validation Session II:
 - ✦ Speech clarity
 - 14 subjects had significant results for main effect of OSPL setting
 - ✦ Speech quality
 - 8 subjects had significant results for main effect of OSPL setting
 - ✦ Acceptable range was found to contain OSPL settings that resulted in degradation of speech quality or clarity
 - ✦ Significant correlations between measured and predicted OSPL for the low freq. channel but not for the high freq. channel



- Results cont...
 - Single vs. Multichannel OSPL Settings
 - ✦ Mean clarity rating was significantly higher for the multichannel condition than single channel
 - Differences in clarity were small between single and multichannel OSPL settings, but the majority did rate the multichannel condition as having higher speech clarity, difference was small so further testing testing should be done
 - ✦ Mean quality rating was not significant for the multichannel and single channel condition
 - ✦ Use of multichannel OSPL predictive technique is acceptable and can be used with confidence

Preminger et al., 2001



- **Conclusions:**
 - Predicted OSPLmin and Predicted OSPLmax are reasonable predictors of measured min and max OSPL levels
 - Use of measured LDLs did not improve accuracy over predicted LDLs for prediction of OSPLmax
 - Validation session I showed range of acceptable OSPL settings, but session II showed poorer speech quality or clarity at the low and high ends of the range
 - Speech clarity was rated higher for the multichannel settings but no speech quality differences between single and multichannel
 - NAL prescriptive procedure for setting OSPL of multichannel hearing aids appears to be suitable for clinical use.
 - ✦ Recommended to be verified by user rating the loudness of an intense sound, and OSPL in high freq. channel and reduce if problems occur

Conclusions:

21

- Overall, studies showed
 - Max. output can be based on measured LDLs or prescribed LDLs, but prescribed is more efficient
 - ✦ Initial setting should be validated at time of fitting to ensure sounds are not uncomfortable regardless of the approach
 - NAL prescriptive procedure for setting max output of multichannel hearing aids appears to be suitable for clinical use.
 - ✦ Cannot generalize to other prescriptive methods

References:

- Mackersie, C. L. (2007). Hearing aid maximum output and loudness discomfort: Are unaided loudness measures needed? *J Am Acad Audiol*, 18, 504-514.
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