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Artigo Original

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Comparative analysis of the NAL-NL2 and DSL v5.0a prescription procedures in the adaptation of hearing aids in the elderly

Análise comparativa dos métodos prescritivos NAL-NL2 e DSL v5.0a na adaptação do AASI em idosos

Keywords

Aged
Hearing
Hearing Loss
Hearing Aids
Speech Perception

ABSTRACT

Purpose: To comparatively analyze the NAL-NL2 and DSL v5.0a prescriptive methods according to the hearing aids individualized programming for the elderly with hearing loss. **Methods:** The study included 60 elderly individuals with hearing loss, who underwent RECD (Real Ear to Coupler Difference) measurement and hearing aids individualized programming by NAL-NL2 and DSL v5.0a prescriptive methods. The performance verification for each prescription was performed using REAR measurements (Real Ear Aided Response), SII calculation (Speech Intelligibility Index) and HINT (Hearing In Noise Test). The comparative statistical analysis was performed using the paired t-test. **Results:** The NAL-NL2 method presented a better performance in the REAR evaluation in low and high frequency bands for medium and loud intensity input sounds, in the high frequency range for low intensity input sounds, and in the SII calculation for soft input sounds. The DSL v5.0a presented better results in the REAR evaluation in medium frequencies for medium input sounds, in low and medium frequencies for soft input sounds, in the SII calculation for medium and loud input sound, and in the HINT test in silent and noisy situations. **Conclusion:** The findings of this study point to an equivalent performance between the DSL v5.0a and NAL-NL2 procedures in the adaptation of hearing aids in the elderly with hearing loss. The amplification calculated by DSL v5.0a provided better speech perception in silence.

Descritores

Idoso
Audição
Perda Auditiva
Auxiliares de Audição
Percepção da Fala

RESUMO

Objetivo: Analisar comparativamente os métodos prescritivos NAL-NL2 e DSL v5.0a de acordo com programação individualizada do AASI para o indivíduo idoso com deficiência auditiva. **Método:** Participaram do estudo 60 indivíduos idosos com deficiência auditiva, submetidos à mensuração da RECD (*Real Ear to Coupler Difference*) e programação individualizada do AASI com os métodos prescritivos NAL-NL2 e DSL v5.0a. A verificação do desempenho com cada prescrição foi realizada por meio das medidas da REAR (*Real Ear Aided Response*), cálculo do SII (*Speech Intelligibility Index)* e teste HINT (*Hearing In Noise Test*). A análise estatística comparativa foi realizada por meio do teste "t" pareado. **Resultados:** O método NAL-NL2 apresentou melhor desempenho na avaliação da REAR em frequências baixas e altas para sons de média e forte intensidade, em frequências altas para sons de fraca intensidade, e no cálculo do SII para sons fracos. O método DSL v5.0a apresentou melhores resultados na avaliação da REAR em frequências médias para sons médios, em frequências baixas e médias para sons fracos, no cálculo do SII para sons médios e fortes, e no teste HINT no silêncio e ruído. **Conclusão:** Os achados deste estudo apontam para um desempenho equivalente entre os métodos DSL v5.0a e NAL-NL2 na adaptação do AASI em idosos com deficiência auditiva. A amplificação calculada pela DSL v5.0a forneceu melhor percepção de fala no silêncio.

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INTRODUCTION

The prescription procedure is the starting point for the adjustments in hearing aids (HA) adaptation, especially during the beginning of the selection, verification and adaptation process. The main objective is the application of recommended amplification for HA users, attending to their interests, which usually involves improving speech perception[1]. Different methods, however, may have different adjustment goals.

It has already been demonstrated[2] that the gain programmed in the HA does not correspond with precision to the gain obtained in the real ear. The most effective way of ensuring that the goals of the adjustment procedure have been achieved is by electroacoustic verification[3-6].

When a prescription algorithm is implemented in a HA, it is applied based on average values of 2cc coupler. It is expected that the result found in the individual's ear is close to target; however, it is based only on 2cc average values, with variations between the individual ears. With this purpose, it becomes necessary to understand the prescription algorithms for pre-programming and the importance of individualized measurement[7].

Regarding these factors, what is performed in clinical practice concerning the adult and elderly population is questioned. Currently the selection and verification protocols for this population are performed in a standardized way, considering average parameters of adult ears that are converted into programming. However, new studies show that in the elderly there are individual characteristics that interfere with the dynamics of the sound that reaches the ear, reducing its amplification due to the alteration of the external acoustic meatus[8,9].

Considering the individualized approach in the adaptation process, a measure that has stood out is RECD (Real Ear to Coupler Difference). This measure suits the proposal of individualization, since it is measured directly in each ear, thus obtaining their actual dimensions, being later converted into programming[10,11]. In this aspect, current research demonstrates the importance of considering this measure in the process of HA selection and adaptation[8,12,13]. This has also been recommended as a necessary measure in the prescription routine of amplification in adults[14,15].

In order to establish the HA electroacoustic characteristics, prescription procedures are proposed, which are complex mathematical applications addressed to the individual needs of the affected population. For example, the prescription procedures NAL-NL2[16] e DSL v5.0a[17].

The NAL-NL2 prescription procedure, second generation of National Acoustic Laboratories (NAL) procedures, and the most recent version of Desired Sensation Level (DSL) procedures, DSL v5.0a, stand out by offering less gain than their previous versions[16-18]. Earlier versions of these generic prescriptions differed greatly in the prescribed gain, with DSL v4 prescribing substantially more gain than NAL-NL1. The latter version of the two prescriptions became much more similar[19], mainly because DSL v5.0a prescribes substantially less gain than DSL v4 for adult HA users[17].

Although in the midst of numerous advances and the possibility of greater coverage by the prescription procedures, there are few studies that guide the process of HA adaptation in the elderly with hearing loss. Given that the HA programming with the initial adjustment often results in differences from the prescribed target, that even small differences can have perceptual consequences, and that previous researches are equivocal as to the relationship between fitting closeness and subjective outcomes[4,20], hearing health professionals need information and more studies regarding the prescription procedures currently available for this population.

In this context, the need for a more detailed study to evaluate the efficiency of prescription procedures was noticed to establish realistic expectations regarding the performance of speech intelligibility with amplification in accordance with the prescription recommendations, and to address the electroacoustic aspects of adaptation, respecting the necessary care with the elderly population, therefore improving these individuals' quality of life.

Thereby, the main purpose of this study was a comparative analysis of the prescription procedures NAL-NL2 and DSL v5.0a according to the individualized HA programming for the elderly with hearing loss, considering the target values prescribed by the procedures, the response curves as a function of frequency, the speech intelligibility index values, and the values measured with speech perception in silence and in noise.

METHODS

The work was approved by the Research Ethics Committee of the institution where the study was developed, under the protocol no. 55685116.4.0000.5417. All participants agreed to participate by signing the Informed Consent Form. The study was developed in a service of the Unified Health System, and was inserted in its routine of care.

The sample consisted of 60 individuals that were selected according to the following inclusion criteria: age equal to or greater than 60 years, mild to severe symmetrical bilateral sensorineural hearing loss, audiometric curve of flat, descending or abrupt configuration[21], indication for bilateral HA adaptation, no otologic surgery, no external ear deformities, intact tympanic membrane, no cognitive impairments, no motor, neurological, psychological or visual disorders and / or serious health problems, and no prior experience with HA.

The selection of the individuals that composed the sample was performed by means of analysis of medical records data. Some were recruited personally after the audiological evaluation, and others were contacted by telephone.

All research procedures were performed on the same day, during approximately one hour and thirty minutes. There was no variation in the order of performance of the evaluation tests due to the availability of the equipment in the institution; however, the programming of each prescription procedure was performed in a random manner. Participants were instructed to inform the researcher if they felt any inconvenience of any nature or discomfort for the time required in order for the approach to be modified or to be offered time for rest.

After that, selection of the HA type and model and meatoscopy was performed. As a procedure of the individualized protocol, personalized programming was considered. Therefore, RECD

was measured in both ears, separately, using AURICAL® equipment of Otometrics, in the OTOsuite module.

For the HA programming, the NOAH v4.0 platform was used in the Hi-Pro programming interface. All HA used were behind-the-ear with mold, and before performing the tests and including each individual in the study, the adjustment of the auricular mold in the external acoustic meatus was performed, in order to guarantee comfort and acoustic seal. For all individuals, HA were selected from the same manufacturer, varying only the model, according to the need based on the degree of hearing loss. Thus, the software used for programming was the same for all participants, eliminating the occurrence of intra-method differences due to the supply of slightly different prescribed targets by different manufacturers. The programming was performed by the software according to the selection of appropriate parameters for each individual, without fine tuning, in two ways: using the prescription procedures NAL-NL2[16] and DSL v5.0a[17], randomly, both executed in the same individual's HA. Data of the measured RECD was inserted into the programming.

Since this study was premised on individualized programming based on RECD values of each individual, and supposing that once the prescription procedure and the maximum level of acclimatization in the programming software were selected, theoretically the target-gain would be achieved in all frequencies; all evaluations were performed without fine-tuning. It is important to note that, after the end of the evaluations, when necessary, modifications in the programming were made in order to meet the preferences of the individuals. However, in all cases, returns were scheduled for follow-ups in the routine of the service.

For this study's evaluations, the performance verification measures for 50, 65 and 80 dBSPL speech stimuli were included, by means of AURICAL® equipment of Otometrics, in the OTOsuite module. REAR (Real Ear Aided Response) measurement and SII (Speech Intelligibility Index)[22] calculation were performed for results comparison. Evaluation was performed in the same way following the protocol for both evaluated procedures, NAL-NL2 and DSL v5.0a.

Speech perception evaluation in each program was performed by applying the HINT (Hearing In Noise Test) test to verify the HA performance with the different prescriptions in speech recognition improvement. Two of the four situations proposed by the test were evaluated as follow: sentence recognition threshold in silence (SRTS) and sentence recognition threshold in noise (SRTN), relative to the signal-to-noise ratio (SNR). The test was performed in a room with acoustic treatment, using the HINT Pro 7.2 Audiometric System (Bio-logic Systems Corp.). Individuals were oriented to remain sitting at a distance of one meter from the sonorous source, in silence and looking forward.

To perform the test, lists containing 20 sentences were randomly selected, and speech and noise were presented in free field. For the presentation of the sentences, the ascending-descending strategy was used to determine the speech recognition threshold (SRT), for an SNR of 50%. In the test, the first four sentences were presented with variations of 4dB, estimating the threshold. From the fifth sentence, variation changed to 2dB and definitive threshold was determined after the presentation of the 20 sentences for each test condition.

SRTS was evaluated without background noise, and the signal (dB NA) was displayed at 0° azimuth and varied in its level according to the individual's response. SNR research was performed with the junction of the signal and the speech-weighted noise, kept constant at 65 dB NA, both presented at 0° azimuth. The noise remained at 65 dB and the speech signal intensity was modified according to the response. When a correct response was obtained, SNR was decreased and, when incorrect, SNR was increased.

Data was analysed and described in tables, using the paired t-test for comparison between the two prescription procedures in REAR, SII and HINT evaluations (SRTS and SRTN). In all statistical tests, a significance level of 5% ($p < 0.05$) was adopted.

RESULTS

The sample consisted of 60 individuals, 36 (60%) of male gender and 24 (40%) of female gender, aged between 62 and 90 years (mean = 77.52, median = 77.5, standard deviation = 7.1).

As to the characteristics of hearing loss, all individuals presented symmetrical bilateral sensorineural hearing loss. Regarding the degree, the sample was composed mostly of moderate degree, with 43 individuals (71.66%), followed by 14 individuals with severe hearing loss (23.33%), and only 3 individuals presenting mild hearing loss (5%). According to the classification of the audiometric curves proposed by Hannula et al.[21], the predominant configuration was descending, with 28 individuals (46.66%). A total of 16 individuals (26.66%) presented abrupt audiometric curve, 14 individuals (23.33%) presented horizontal curve and 2 individuals (3.33%) had the curve configuration classified as unspecified.

The presentation of the results concerning the probe tube measurements was given considering the evaluation by ear, therefore, totalling 120 ears. The comparison of the HINT test results was presented only for the total sample of 60 individuals, since it was a bilateral measurement performed simultaneously.

Table 1 shows the comparison of the mean of REAR values in relation to the target of the prescription procedures NAL-NL2 and DSL v5.0a in the evaluation with 50 dB of intensity and the significance between them. It is possible to notice that there was statistical difference in the frequencies of 250, 1000, 2000 and 6000 Hz, but without performance unanimity from one of the procedures.

Table 2 shows the comparison of the mean of REAR values in relation to the target of the prescription procedures NAL-NL2 and DSL v5.0a in the evaluation with 65 dB of intensity and the significance between them. Again without unanimity of performance from one of the procedures, there was statistical difference in all evaluated frequencies.

Table 3 shows the comparison of the mean of REAR values in relation to the target of the prescription procedures NAL-NL2 and DSL v5.0a in the evaluation with 80 dB of intensity and the significance between them. Statistical difference was found in all frequencies evaluated, with better performance of the DSL v5.0a procedure only in the frequency of 2000 Hz.

Table 4 shows the comparison of the mean of Speech Intelligibility Index values obtained with the prescription procedures NAL-NL2 and DSL v5.0a in the evaluation with

intensities of 65, 50 and 80 dB and the significance between them. There was statistical difference in the three evaluated intensities, in which the NAL-NL2 procedure presented better performance only on low intensity.

Table 5 shows the comparison of the mean of values obtained in speech perception evaluation in silence and in noise with the prescription procedures NAL-NL2 and DSL v5.0a, as well as the significance between them. Statistical analysis showed

Table 1. Comparison of the mean of REAR values in relation to the target of the prescription procedures NAL-NL2 and DSL v5.0a in the evaluation with 50 dB of intensity

Freq. (Hz)	PP	NAL-NL2	x (sd)	DSL v5.0a	p
250		-6.88 (5.98)		**-4.21 (8.75)**	0.000*
500		-5.24 (6.03)		-4.98 (6.77)	0.525
1000		-5.41 (4.83)		**-0.99 (4.52)**	0.000*
2000		-6.23 (4.39)		**-0.88 (5.31)**	0.000*
3000		-5.43 (4.80)		-5.16 (5.48)	0.484
4000		-6.86 (6.33)		-7.04 (5.82)	0.728
6000		**-14.20 (6.80)**		-18.88 (8.00)	0.000*

Caption: Freq.: frequency; PP: prescription procedure; Hz: hertz; x: mean; sd: standard deviation; (p)*: statistically significant difference; negative values are below target; x and sd: presented in dB SPL; best values highlighted in bold

Table 2. Comparison of the mean of REAR values in relation to the target of the prescription procedures NAL-NL2 and DSL v5.0a in the evaluation with 65 dB of intensity

Freq. (Hz)	PP	NAL-NL2	x (sd)	DSL v5.0a	p
250		**-3.81 (6.07)**		-4.92 (8.15)	0.036*
500		**-3.15 (5.42)**		-6.39 (6.16)	0.000*
1000		-7.06 (4.65)		**-4.15 (4.05)**	0.000*
2000		-5.11 (4.01)		**-2.75 (4.46)**	0.000*
3000		**-4.92 (4.62)**		-7.33 (5.17)	0.000*
4000		**-5.83 (5.59)**		-9.17 (5.93)	0.000*
6000		**-14.29 (6.99)**		-20.52 (9.38)	0.000*

Caption: Freq.: frequency; PP: prescription procedure; Hz: hertz; x: mean; sd: standard deviation; (p)*: statistically significant difference; negative values are below target; x and sd: presented in dB SPL; best values highlighted in bold

Table 3. Comparison of the mean of REAR values in relation to the target of the prescription procedures NAL-NL2 and DSL v5.0a in the evaluation with 80 dB of intensity

Freq. (Hz)	PP	NAL-NL2	x (sd)	DSL v5.0a	p
250		**-0.35 (4.31)**		-6.97 (7.90)	0.000*
500		**-0.61 (8.18)**		-7.67 (5.82)	0.000*
1000		**-5.68 (4.83)**		-6.60 (3.65)	0.006*
2000		-5.00 (4.30)		**-3.78 (4.00)**	0.000*
3000		**-5.11 (4.94)**		-8.99 (4.46)	0.000*
4000		**-5.85 (5.32)**		-9.21 (5.32)	0.000*
6000		**-14.45 (6.52)**		-19.93 (8.31)	0.000*

Caption: Freq.: frequency; PP: prescription procedure; Hz: hertz; x: mean; sd: standard deviation; (p)*: statistically significant difference; negative values are below target; x and sd: presented in dB SPL; best values highlighted in bold

Table 4. Comparison between NAL-NL2 and DSL v5.0a in SII analysis

SII	PP	NAL-NL2	x (sd)	DSL v5.0a	p
50 dB SPL		**21.65 (12.01)**		16.09 (10.58)	0.000*
65 dB SPL		40.00 (14.34)		**43.00 (13.19)**	0.000*
80 dB SPL		54.67 (14.08)		**63.10 (11.70)**	0.000*

Caption: SII: Speech Intelligibility Index; PP: prescription procedure; x: mean; sd: standard deviation; (p)*: statistically significant difference; x and sd: presented in %; best values highlighted in bold

Table 5. Comparison between NAL-NL2 and DSL v5.0a in HINT (Hearing In Noise Test) evaluation

Test	PP	NAL-NL2				DSL v5.0a				p
		x (sd)	min	max	med	x (sd)	min	max	med	
SRTS (dB A)		58.33 (9.39)	43	86.90	57.15	**56.87 (9.23)**	43.30	86.20	55.65	0.0059*
SRTN (dB NA)		+ 7.12 (5.19)	0	21.70	6.20	+ 6.64 (5.61)	-0.10	23.60	5.35	0.1691

Caption: SRTS: Sentence Recognition Threshold in Silence; SRTN: Sentence Recognition Threshold in Noise; PP: prescription procedure; x: mean; sd: standard deviation; min: minimum value; max: maximum value; med: median; (p)*: statistically significant difference; best values highlighted in bold; SRTN values referring to the signal-to-noise ratio

better performance of DSL v5.0a procedure, with statistical difference in the evaluation in silence.

DISCUSSION

In the field of audiology, the branches that currently study the adult and elderly population are increasingly common, accompanying their growth and meeting the demands of this differentiated group. In the context of HA selection and adaptation process, an important aspect to consider is the different emphases in the calculations presented by each prescription procedure according to its guidelines, and the specific population for which it was designated, especially considering the characteristics of presbycusis.

In this perspective, this study considered comparative aspects of the values of prescription targets, correlating with the results of verification, speech perception, the individual anatomical characteristics, and the specific preferences and needs of the elderly, with the purpose of more appropriate planning for this population regarding the HA selection and adaptation.

The evaluations of REAR measurements in relation to the prescribed target were performed with the purpose of comparing the obtained values by frequency with the NAL-NL2 and DSL v5.0a prescription procedures. No analysis was performed to compare the results of each method to the prescribed target. However, for the purpose of observing objective results, the criteria of Mueller et al.[23] was adopted to verify the equivalence, which establishes a difference of ± 5dB between the REAR values and the prescribed target, justifying that, as a function of potential for calculation and measurements errors and differences in loudness preference between individuals, the target represents a certain extent of values and not a single value.

Therefore, in 50 dB intensity, REAR measurements revealed better performance of DSL v5.0a in low and medium frequencies, while NAL-NL2 indicated a better result in high frequencies (Table 1). The study by Dworsack-Dodge[7] presented partially different findings, indicating that for a low input level the prescribed gains of NAL-NL2 and DSL v5.0a resemble in medium frequency range and differ in low and high frequencies, with more gain prescribed by NAL-NL2 in low frequencies, and more gain in high frequencies by DSL v5.0a, considering the target of an adult with descending hearing loss. In the bibliographic search that was conducted, it was possible to verify that the published works that designate the gain by frequency at different intensities for the present prescription procedures are scarce.

In 65 dB of intensity, the evaluation of REAR measurements indicated a better performance of NAL-NL2 in low and high frequencies, while DSL v5.0a was more satisfactory in average frequencies (Table 2). Such data differs from previous studies. Dworsack-Dodge[7] demonstrated similarity between the prescriptions in average frequencies and divergences in frequency extremities for an input level of 65 dB, with NAL-NL2 providing more gain in low frequencies and less gain in high frequencies in relation to DSL v5.0a. The study by Johnson and Dillon[19] evaluated the impact of insertion gain differences among some prescription procedures for different hypothetical configurations of hearing loss considering adult individuals. In this comparison, DSL v5.0a prescribed lower gain in medium and low frequencies up to 4000 Hz and greater gain in 6000 and 8000 Hz than NAL-NL2 for audiograms representing sensorineural losses of varied configurations.

The evaluation of REAR measurements at 80 dB intensity indicated that DSL v5.0a was more satisfactory only at the frequency of 2000 Hz, while in low and high frequency bands there was a better performance of NAL-NL2 (Table 3). The lack of works that study the most recent versions of NAL and DSL procedures makes it impossible to compare these results with previously published data. However, regarding the previous versions of these prescriptions, NAL-NL1 and DSL [i/o] (v4.1), the study by Venema[24] conducted with hypothetical audiograms concluded that, for intense input sounds, NAL-NL1 prescribes more gain than DSL [i/o] (v4.1). Although these are not the same versions studied here, following the premise that prescription procedures maintain their philosophies and guidelines throughout their evolutions, one can observe a concordance between the findings in the sense that, for a loud input level, procedure NAL presented better overall performance compared to DSL in both situations.

In relation to the SII calculation, Sanders et al.[25] propose that, for a low intensity input, the SII value should be on average 47; for average input levels, 65; and for a strong input, 73. In this study, for an input signal of 50 dB SPL, the obtained value in percentage was higher in the measurement with NAL-NL2, while for intensities of 65 and 80 dB SPL, DSL v5.0a showed higher values (Table 4). These results indicate that NAL-NL2 provides a greater number of audible and useful speech information when the individual is exposed to a low-intensity speech signal, and DSL v5.0a performs better in this sense with medium and high input signals.

Diverging from these findings, Johnson[1] suggests a better overall result with NAL-NL2 for predicted SII when compared to DSL v5.0a for the adult population. However, the author states that DSL v5.0a performs best for medium and high input levels in high frequency audibility. Given this additional audibility, it is reasonable to think that DSL v5.0a may allow individuals with lower thresholds at high frequencies to have additional speech intelligibility benefits. This statement is consistent with the results obtained in this study, since the majority of the studied sample presented a descending or abrupt audiometric configuration (73%), that is, with a lowering of high frequencies.

However, it is very important to emphasize that, although SII allows an estimation of speech audibility, some relevant limitations should be considered. SII represents the amount of audible speech in a typical listening situation. Nevertheless, because of the variability in speech acoustics in different listening situations, SII may overestimate or underestimate audibility. Recent studies have shown that similar SII values may result in very different levels of speech comprehension depending on which frequency bands are audible to the listener[19,26].

Regarding speech perception evaluation, DSL v5.0a obtained better performance in both evaluated situations, since it conferred a decrease of threshold in SRTS evaluation and of SNR in SRTN evaluation, although in this second situation the

difference between prescriptions was not statistically significant. This is a very relevant finding, especially considering the adult population's dissatisfaction with the predecessor procedure DSL v4.1, which presented a prescribed gain greater than the preferred, especially in low frequencies[17,27-29].

In summary, the present study contributes to directing the answer to the question about the best alternative of prescription in the programming of HA for the elderly with hearing loss, indicating the performance of the prescription procedures in each evaluation. In general, it was not possible to establish a more satisfactory procedure in all evaluated parameters.

Regarding the speech perception evaluation, which is fundamental in studies including the elderly, there was a discrete but relevant difference between the prescription procedures, with a better result for DSL v5.0a when assessed in silence (Table 5). This is due to the proposal of the most recent DSL formula, which presents modifications that emphasize aspects of speech perception in noise and the comfort of the user. This finding does not determine the superiority of DSL v5.0a over NAL-NL2, however it allows using this procedure with other populations besides the pediatric, which is already substantiated, offering a satisfactory alternative concerning the speech perception in silence and in noise for younger adults and the elderly with hearing loss.

The present study aimed to demonstrate objective results of comparison between the NAL-NL2 and DSL v5.0a prescription procedures, in a general analysis of the obtained values with the elderly with hearing loss. The continuity of studies involving older individuals is of extreme relevance, considering the individual characteristics of this population and the need to establish a specific clinical practice for them. The establishment of different audiological profiles among this population, taking into account the different degrees of hearing loss and audiometric configurations, is important to determine the best practice for each individual in the context of HA programming and adaptation, according to all steps and parameters to be taken into account for a better result.

CONCLUSION

The findings of this study point to an equivalent performance between DSL v5.0a and NAL-NL2 prescription procedures in HA adaptation in the elderly with hearing loss. The amplification calculated by DSL v5.0a provided better speech perception in silence.

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Authors' contributions

MCB participated in the idealization of the study, data collection, analysis and interpretation and article writing; WQB participated, in the condition of advisor, in the idealization of the study, analysis, interpretation of data and writing of the article.